NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY


NGA.IP.0001_1.0
2008-11-18

# NGA STANDARDIZATION DOCUMENT

# Implementation Profile
# for
# Tagged Image File Format (TIFF)
# and
# Geographic Tagged Image File Format (GeoTIFF)

**SPECIFICATION FOR TIFF AND GeoTIFF FORMATTING OF IMAGERY AND GRIDDED DATA WITH GUIDELINES FOR SUPPLEMENTARY METADATA**

## (2008-11-18)

## Version 1.0

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**NATIONAL CENTER FOR GEOSPATIAL INTELLIGENCE STANDARDS**

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# Foreword

An important area of consideration for the use of imagery and gridded data is the encoding format. Various participants within the National System for Geospatial-Intelligence (NSG) have validated requirements to make selected imagery and gridded data holdings available in Geographic Tagged Image File Format (GeoTIFF), in addition to other NSG-supported formats. The primary rationale is to enable more timely (through automation) support for delivering imagery and gridded data in a form suitable for direct ingest by the imagery and Geospatial Information System (GIS) application software tools readily available to those working in the civilian sector supporting disaster relief, homeland security, and similar activities. Implementation requirements are already being worked for imagery libraries to begin some simple, initial support for GeoTIFF, but there are no standardized implementation profiles in place to guide the deployment of this functional capability. While GeoTIFF is widely used within the civilian sector, it has many options which often result in non-interoperability among disparately developed implementations. This implementation profile was developed to help meet objectives for deployment of GeoTIFF-related capabilities within the NSG that will also be widely supported within the civilian sector.

Most data exchange standards are defined in terms of their encoding format. Often, information about the structure of the format itself dominates, and the information elements that describe the underlying nature of the data (metadata) are a secondary consideration. In many instances, the information elements pertinent to understanding the nature of the data are not included with the data to be exchanged, and users of the data must depend on a priori knowledge that may, or may not be externally documented. GeoTIFF, like other formats popular in the civilian sector, is not robust enough in its defined structure to fully carry even the minimal set of metadata needed to promote interoperability within the NSG. This profile identifies a recommended approach to supplement missing information not captured by the current GeoTIFF data structures.

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## Introduction

This implementation profile specifies the high-level requirements and encoding rules that shall be used for the exchange of imagery and gridded data when opting to use the Tagged Image File Format (TIFF) and Geographic Tagged Image File Format (GeoTIFF) file format structures. It constitutes a description of the bounds and constraints for the use of TIFF and GeoTIFF within the design objectives of promoting interoperability for the exchange of GeoTIFF files within the National System for Geospatial Intelligence (NSG).

GeoTIFF is a public domain specification which allows georeferencing information to be embedded within a TIFF file. The potential additional information includes projections, coordinate systems, ellipsoids, datums, and other information needed to establish the spatial reference for the imagery or gridded data contained in the file. The GeoTIFF format augments the TIFF format, so TIFF-enabled software incapable of reading and interpreting the specialized georeferencing metadata should still be able to open a GeoTIFF file sufficiently to at least view the image data.

The main body of this profile addresses the general approach for using TIFF/GeoTIFF within the general context of imagery and gridded data. Appendix A outlines the internal TIFF/GeoTIFF data structures and defines the rules for representing imagery and gridded data using the syntax, structure and coding scheme available within the TIFF/GeoTIFF format. Appendix B describes the supplemental metadata to be associated with each GeoTIFF file. Appendix C provides metadata XML schema information for the supplemental metadata, and Appendix D provides an example of supplemental metadata to include a sample XML-encoded instance document. Lastly, Appendix E defines the abstract test criteria for measuring conformance with this profile when representing imagery and gridded data using TIFF/GeoTIFF.

Users of this profile are encouraged to develop an application-specific implementation profile(s) to capture the detailed design for using TIFF/GeoTIFF within the context of the intended deployment of GeoTIFF-encoded data, services and capabilities.

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# TIFF/GeoTIFF Formatting of Imagery and Gridded Data

## 1 Scope

This implementation profile defines the minimum set of format options, features, and data elements (to include metadata) necessary to promote interoperability for the exchange of Geographic Tagged Image File Format (GeoTIFF)-formatted files within the National System for Geospatial-Intelligence (NSG). This profile establishes a common frame of reference to address adequate georeferencing parameters and data value attribution needed by geospatial applications to utilize GeoTIFF-formatted image and gridded data. Only uncompressed imagery, gridded data and transparency masks that have been georeferenced (orthorectified, georectified or equidistant-sampled data) are addressed by this profile. Requirements for compression (see Section 7.13) and georeferencable imagery (see Section 7.2) shall not be addressed by the NSG using the GeoTIFF format.

Tagged Image File Format (TIFF) is an image file format used for storing and interchanging raster images. Gridded data (for example, elevation values, an array of lat/long points, etc.) can be carried as an array much like an image, using the TIFF format. It is a portable format, not specific to or favoring any particular operating systems, file systems, compilers, or processors. It is also extensible and designed to evolve as new needs arise.

GeoTIFF is a set of TIFF tags (extensions to the Baseline TIFF Format) that describe cartographic information associated with TIFF imagery and gridded data that originate from satellite imaging systems, scanned aerial photography, scanned maps, digital elevation models, or as a result of geographic analysis or similar processes. It uses a small set of reserved TIFF tags to store a broad range of geo-referencing information.

This profile addresses the following fundamental topics for application and use of TIFF/GeoTIFF:

- Required TIFF/GeoTIFF tags for standardized use of GeoTIFF-formatted files.
- Image data or pixel structures relating to: strips, tiling, compression, precision, number of bands, etc.
- Preferred coordinate reference systems, datums, and projections for use within the NSG.
- Minimum metadata requirements for use within the NSG.

## 2 Conformance

Any data claiming conformance with this profile shall pass the conformance requirements described in Appendix E.

Any product or system claiming conformance for generating data in compliance with this profile shall pass the conformance requirements described in Appendix E.

Any product or system claiming conformance for interpreting data in compliance with this profile shall pass the conformance requirements described in Appendix E.

## 3 Normative Documents

“The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.”

Industry Specifications:
The format and contents of the TIFF and GeoTIFF are based upon the following industry specifications;

TIFF – Tagged Image File Format, Revision 6.0, Adobe Systems Inc., June 1992
http://partners.adobe.com/public/developer/en/tiff/TIFF6.pdf


GeoTIFF Format Specification, Revision 1.0, 10 November 1995; version 1.8.2
http://www.remotesensing.org/geotiff/spec/geotiffhome.html


International Standards Organization publications: http://www.iso.org/iso/store.htm

ISO 639-3: 2007 Codes for the Representation of Names and Languages

ISO 3166-1: 2006 Codes for the Representation of Names of Countries and their subdivisions

ISO 8601: 2004 Data Elements and Interchange Formats – Information Interchange – Representation of Dates and Times

ISO 19107: 2003 Geographic Information – Spatial Schema

ISO 19108: 2002 Geographic Information – Temporal Schema

ISO 19115: 2003 Geographic Information – Metadata

ISO/DIS 19115-2 Geographic information - Metadata - Part 2: Extensions for imagery and gridded data (not yet published)

ISO 19123: 2005 Geographic Information – Schema for Coverage Geometry and Functions

ISO 19139: 2007 Geographic Information – Metadata – XML Schema Implementation

National Standards:

National System for Geospatial Intelligence (NSG) Geospatial Core Metadata Profile (NGCMP), version 1.0, August 2007. http://www.gwg.nga.mil/stds_regs.html#25mil_stds

NIMA TR 8350.2: Third Edition, Amendment 1: Department of Defense World Geodetic System 1984; Its Definition and Relationships with Local Geodetic Systems. U. S. National Imagery and Mapping Agency 3 January 2000. http://earth-info.nga.mil/GandG/publications/tr8350.2/wgs84fin.pdf

NIMA TM 8358.2: The Universal Grids: Universal Transverse Mercator (UTM), Universal Polar Stereographic (UPS) http://earth-info.nima.mil/GandG/publications/tm8358.2/TM8358_2.pdf

Intelligence Community Standard for Resource Metadata: Metadata Element Set - Data Element Dictionary (ICRM: MES), Version 2.0., 9 January 06 (formerly known as IC Standard for Core Metadata (IC Core))

Intelligence Community Metadata Standard for Information Security Markings, 15 August 2006

Federal Information Processing Standards (FIPS) 10-4; Countries, Dependencies, Areas of Special Sovereignty, and Their Principal Administrative Divisions http://earth-info.nga.mil/gns/html/gazetteers2.htm

# 4 Terms and Definitions

For the purposes of this document, the terms and definitions given in the TIFF and GeoTIFF specifications apply, in addition to the following;

### 4.1 abstract test case
An encapsulation of one or more test puposes, independent of both the implementation and the values. It enables a test verdict to be assigned unambiguously to each potentially observable test outcome (i.e. sequence of test events).

### 4.2 abstract test suite (ATS)
A collection of test modules and individual test cases that provide a formal basis for deriving executable test cases.

### 4.3 absolute accuracy
Evaluation of all errors in determining a position with respect to an absolute reference frame, such as the World Geodetic System 1984 (WGS84).

### 4.4 band
A well defined range of wavelengths, frequencies or energies of optical, electric, or acoustic radiation. At the pixel level, a band is represented as one of the vector values of the pixel.

### 4.5 coordinate
One of a sequence of numbers designating the position of a point in N-dimensional space.

### 4.6 bandwidth
The difference between the limiting frequencies within which performance of a device, in respect to some characteristic, falls within specified limits. 2. The difference between the limiting frequencies of a continuous frequency band.

### 4.7 coordinate reference system
Coordinate system which is related to the real world by a datum.

### 4.8 coverage
Feature that acts as a function to return values from its range for any direct position within its spatial, temporal, or spatiotemporal domain. Examples include a digital image, raster map, and digital elevation matrix.

*Note: In other words, a coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.*

### 4.9 coverage geometry
Configuration of the domain of a coverage described in terms of coordinates.

### 4.10 data compaction
Reduction of the number of data elements, bandwidth, cost, and time for the generation, transmission, and storage of data without loss of information by eliminating unnecessary redundancy, removing irrelevancy, or using special coding. Note: Whereas data compaction reduces the amount of data used to represent a given amount of information, data compression does not.

### 4.11 data compression
Compression reduces the amount of storage space required to store a given amount of data, or reducing the length of message required to transfer a given amount of information. Note: Data compression does not reduce the amount of data used to represent a given amount of information, whereas data compaction does. Both data compression and data compaction result in the use of fewer data elements for a given amount of information.

### 4.12 dataset
Identifiable collection of data.

### 4.13 domain
Well-defined set. Note: Domains are used to define the domain set and range set of operators and functions.

### 4.14 direct position
Position described by a single set of coordinates within a coordinate reference system.

### 4.15 evaluation
Determination of the values of a coverage at a direct position within the spatiotemporal domain of the coverage.

### 4.16 executable test case
A specific test of an implementation to meet particular requirements.

### 4.17 function
Rule that associates each element from a domain (source, or domain of the function) to a unique element in another domain (target, co-domain, or range).

### 4.18 georectified grid
Rectified grid wherein the external coordinate reference system is related to the real world by a datum. Note: Any cell in the grid can be geolocated given its grid coordinate and the grid origin, cell spacing, and orientation.

### 4.19 grid
Network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in a systematic way.

### 4.20 gridded data
Data whose attribute values are associated with positions on a grid coordinate system.

### 4.21 grid point
Point located at the intersection of two or more curves in a grid.

### 4.22 imagery
Representation of phenomena as images produced electronically and/or optical techniques.

### 4.23 implementation conformance Statement (ICS)
Statement of specification requirements and options that have been implemented.

### 4.24 implementation under test (IUT)
The realization of a specification that is being reviewed for conformance with the specification.

### 4.25 metadata
Data about data.

### 4.26 mosaic
For purposes of this profile, a mosaic image is an image composed of two or more separately collected (sensed) images. Supplemental metadata may be used to identify the cut-lines (boundaries and parameters for the images used to compose the mosaic.

### 4.27 orthorectified grid
Georectified grid created using ground control points and elevation data where constant scale is maintained throughout the grid.

### 4.28 pixel
A single point in a graphic image. Each such information element is not really a dot, nor a square, but an abstract sample. With care, pixels in an image can be reproduced at any size without the appearance of visible dots or squares. The intensity of each pixel is variable; in color systems, each pixel has typically three or four dimensions of variability such as red, green, and blue, or cyan, magenta, yellow, and black.

### 4.29 range
Set of feature attribute values associated by a function with the elements of the domain of a coverage.

### 4.30 record
Finite, named collection of related items (objects or values). Note: Logically, a record is a set of pairs <name, item >.

### 4.31 rectified grid
Grid for which there is an affine transformation between the grid coordinates and the coordinates of an external coordinate reference system.

### 4.32 referenceable grid
Grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to an external coordinate reference system

### 4.33 relative accuracy
Evaluation of the random errors in determining the position of one point or feature with respect to another.

### 4.34 tile
A tile is a bounded set of data that is edge-matched with other tiles within a tiling scheme.

## 5 Symbols and Abbreviated Terms

| | |
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| ASCII | American Standard Code for Information Interchange |
| DMA | Defense Mapping Agency |
| GCS | Geographic Coordinate System |
| GCSE | Geographic Coordinate System, Ellipsoid Only |
| GeoTIFF | Geographic Tagged Image File Format |
| GIS | Geospatial Information System / Geographic Information System |
| GWG | Geospatial Intelligence Standards Working Group |
| IEEE | Institute of Electrical & Electronic Engineers |
| IFD | Image File Directory |

| | |
|---|---|
| IHO | International Hydrographic Organization |
| ISO | International Organization for Standardization |
| MFG | Metadata Focus Group (a focus group within the GWG) |
| NIMA | National Imagery and Mapping Agency |
| NSG | National System for Geospatial-Intelligence |
| TIFF | Tagged Image File Format |
| UTC | Coordinated Universal Time |
| UPS | Universal Polar Stereographic |
| UTM | Universal Transverse Mercator |
| WGS84 | World Geodetic System 1984 |

# 6 Applicability and Use

This profile is applicable to the exchange of imagery and gridded data. The use of metadata allows great flexibility of data structure, spatial density, quality, and format, while supporting sharing and reuse of the data.

Intended users include:

- New and existing imagery and gridded data acquisition systems.
- GeoTIFF exploitation systems and applications.
- GeoTIFF users who create derived data from GeoTIFF files or from other image and gridded data file formats.
- Users who create GeoTIFF files from non-imagery datasets i.e. bathymetry, terrain elevation data, etc.
- Users who need to create GeoTIFF files with a different security classification and/or releasibility designation in support of distribution requirements.

Users of this profile are encouraged to develop an application-specific implementation profile(s) to capture the detailed design for using TIFF/GeoTIFF within the context of the intended deployment of GeoTIFF-encoded data, services and capabilities.

# 7 TIFF and GeoTIFF Requirements

In general, imagery and gridded data delivered in GeoTIFF format will conform to (not deviate from) the TIFF and GeoTIFF formats as defined in the referenced TIFF and GeoTIFF specifications. The following clauses constrain the implementation of TIFF and GeoTIFF for the purposes of this implementation profile.

## 7.1 General File Structure and Data Value Types

The TIFF structure includes an 8-byte image file header that points to the first Image File Directory (IFD). There must be at least 1 IFD in a TIFF file and each IFD must have at least one entry. The IFD contains information about the image, as well as pointers to the actual data. All used fields are listed, and information that does not fit in the IFD is listed in other parts of the file. The IFD begins with a 2-byte count of the number of directory entries (i.e., the number of fields), followed by a sequence of 12-byte field entries, and followed by a 4-byte offset of the next IFD (or 0 if none). It should be noted that the 4-byte (32 bit) structure of the offset allows GeoTIFF file sizes up to 4GB. This implementation profile supports file sizes up to that limit. For datasets above the 4GB limit, producers may employ external tiling, which is described in sections 7.10 and 7.15.

All of the GeoTIFF information is encoded in six TIFF tags, which are designed to store a broad range of georeferencing information, catering to geographic as well as projected coordinate system needs.

GeoKeys are used within the tags to store the projection parameters and coordinate system information. All keys are referenced from one tag, the GeoKeyDirectoryTag. See Table 2, Appendix A for details. Not all the keys will be used when formatting GeoTIFF in conformance with this profile. This profile requires that only certain essential GeoTIFF keys be populated. Others may require default values.

The GeoTIFF specification requires interpret (reader) implementations to support all documented TIFF 6.0 tag data-types, and in particular requires the Institute of Electrical & Electronic Engineers (IEEE) double-precision floating point 'DOUBLE' type tag. The documented data types for use with TIFF tags are:

- BYTE = 8-bit unsigned integer
- ASCII = 8-bit byte that contains a 7-bit American Standard Code for Information Interchange (ASCII) code. The last byte of an ASCII sequence (string) must be null (binary zero)
- SHORT = 16-bit (2-byte) unsigned integer
- LONG = 32-bit (4-byte) unsigned integer
- FLOAT = Single precision (4-byte) IEEE format
- DOUBLE = Double precision (8-byte) IEEE format
- RATIONAL = Two LONGs: the first represents the numerator of a fraction; the second, the denominator
- SBYTE = 8-bit signed (twos complement) integer
- UNDEFINED = 9-bit byte containing anything, depending on the definition of the field.
- SSHORT = 16-bit (2-byte) signed (twos complement) integer
- SLONG = 32-bit (4-byte) signed (twos complement) integer
- SRATIONAL = Two SLONGs: the first represents the numerator of a fraction; the second, the denominator.

*Note: Appendix A identifies which data type applies to each tag selected for use by this implementation profile.*

The optional transparency mask implements the padding information; this mechanism, specified in TIFF "Additional Baseline", is common for geospatial raster data. It is specified by using a second IFD. A transparency mask is a bi-level image that is perfectly superposable to the image data (pixel to pixel) specified by first IFD. This profile implements transparency mask with the same size and resolution as main image data. In the transparency mask, the value of 1 indicates a significant pixel whereas a value of 0 indicates a padding pixel that should be rendered as transparent. A transparency mask contains no GeoTIFF tags. The following TIFF tags and values (see Appendix A) are used to specify a transparency mask:

- BitsPerSample = 1
- Colormap: do not use
- ImageDescription: Include "transparency mask" in abstract portion
- ImageLength = (ImageLength of 1st IFD)
- ImageWidth = (ImageWidth of 1st IFD)
- NewSubfileType: (set second bit = 1, all other bits = 0)
- PhotometricInterpretation = 4
- SamplesPerPixel = 1

TIFF implicitly types all range values (data sample values) as unsigned integer values. The representation of imagery and gridded data range values, however, requires the ability to store the range (data) values in additional representations such as signed integer and floating point. Section 19 of the TIFF specification presents a scheme for describing a variety of data sample formats. The BitsPerSample field in the TIFF Image File Directory defines the number of bits per component.

## 7.2 Rectification and Ortho-rectification

A rectified grid is related to the earth (georectified) or other reference by an affine transform based on the location of the origin of the grid and the orientation of and spacing along each axis. An orthorectified grid is a georectified grid created using ground control points and elevation data where constant scale is maintained throughout the grid.

A referenceable grid is one that can be referenced by some other specified coordinate transform (for example, by a physical sensor geometry model or by a functional fit model of rational polynomials). This profile is concerned only with georectified grids and orthorectified grids. It does not address referenceable grids; for example, those associated with oblique imagery.

The GeoTIFF format specification describes 5 coordinate transformation 'cases' that the format is able to address. In cases 1 and 2, the location of at least one point is known, but scale is not. This profile requires that the scale be identified in the GeoTIFF tags (see Table A.2), and therefore cases 1 and 2 are not supported and the GeoTIFF format shall not be used by the NSG unless the size of the image pixel spacing is known. Cases 3 and 4 are supported by this profile. In case 3, the position and scale of the data is known exactly, and no rotation of the image is required. In case 4 (intended for equidistant-sampled data), rotation is required and additional information is needed in the form of a transformation matrix. The ModelTransformationTag exists for the purpose of allowing this information to be provided. In case 5 (not allowed by this profile) multiple tie points can be stored in GeoTIFF to allow rubbersheeting of the image. There is no GeoTIFF tag structure to support the sensor model information that would be required to precisely georeference an "as-collected" image. Precise positioning is therefore not a baseline GeoTIFF implementation, and georeferencable images are not supported by this profile.

## 7.3 Security Classification

There are no fields for storing security classification information in the TIFF/GeoTIFF format. Supplemental metadata in the embedded or associated XML expressions (see section 7.17) shall be used to associate security markings and dissemination controls for content of GeoTIFF files. For this profile, the Security Core section of the NSG Geospatial Core Metadata Profile (NGCMP), and the Intelligence Community Metadata Standard for Information Security Markings (ICS ISM) were referenced in the development of supplemental metadata associated with security.

## 7.4 Void and Suspect Areas

A void is an area within the coverage where the range value does not represent an actual measurement. Suspect areas are those with elevation values that fall outside of the dataset's range of logical consistency (i.e. spikes and valleys). There are no baseline TIFF or GeoTIFF tags for storage of information about void and suspect areas. Identification of these postings could be handled via the associated supplemental metadata defined for the specific application of GeoTIFF. However, for efficiency within the encoding, void and suspect areas shall be represented within the TIFF matrix of range values by use of a designated "out-of-range" value, typically the most negative value available for the data type selected (or the non-number value designated for the selected data type) to represent the range values. An unofficial private TIFF tag, GDAL_NODATA (#42113) exists for the pupose of declaring this value (see Table A.1). Note that since GeoTIFF could be used to support features such as elevation and bathymetric surfaces, due care must be taken when using a negative "out-of-range" value to avoid confusion with actual data values.

## 7.5 Data Quality

There are no fields for storing data quality information (positional accuracy, lineage, currency, etc.) in the GeoTIFF format. The supplemental metadata in the associated XML expressions shall be used to address data quality descriptions.

## 7.6 Units of Measure

Common industry practice is to allow implied or default units of measure, and this profile allows only the impied 'angular degree' unit for the geographic coordinate system, and the default 'meters' unit for the UTM projected coordinate system. User-defined geographic or projected coordinate systems are not allowed by this profile. In order to prevent the use of other horizontal units of measure, the use of the GeoKeys related to horizontal units of measure are prohibited (see section A.2).

Several vertical coordinate systems are allowed by this profile, but the vertical unit of measure shall always be the linear meter. Elevation data in GeoTIFF format shall declare this unit using the VerticalUnitsGeoKey in Table A.2.4.

## 7.7 Date and Time

There is a TIFF field called DateTime for storing the date and time of image creation. The format for the field in ASCII type is "YYYY:MM:DD HH:MM:SS " with 24 hour time used for the hours and one space character between the date and time, and one terminating null character. The length of the string, including the terminating null, is 20 bytes. All dates and times shall be expressed in Coordinated Universal Time (UTC).

The Date/Time stamp that will be represented in the TIFF DateTime field shall be the date/time the imagery or gridded range values were collected. For data composed from data collection conducted at different times (e.g. mosaics), the general guideline is to use the data/time from the oldest (least current) collection. Use the date and time that most closely reflects the currency of the data range values. The associated XML metadata expressions allow other types of date/time elements that deal with modification dates, exchange dates, or processing dates, but there is no provision within TIFF/GeoTIFF to express these other varieties of dates and times.

## 7.8 Coordinate Reference Systems and Datums

The GeoTIFF Configuration GeoKeys establish the general configuration of the file's coordinate system. Each of these GeoKeys is listed below with their general description followed by limitations and constraints established by this profile.

- GTModelTypeGeoKey – Tag 1024. The GTModelTypeGeoKey defines the general type of model coordinate system used – geographic or projected.

- GTRasterTypeGeoKey– Tag 1025. The GTRasterTypeGeoKey establishes if the raster pixel value (imagery or gridded data range value) is located at a point value or if the value fills the square grid cell.

- GTCitationGeoKey – Tag 1026. The GTCitationGeoKey is used to give an ASCII reference to published documentation on the overall configuration of the GeoTIFF file. This key generally shows the projection name or geographic coordinate system name and the units.

Horizontal datum – GeoTIFF has many datums to choose from in the Geodetic Datum numerical codes. This profile limits the horizontal datum to the World Geodetic System 1984 (WGS84).

Vertical datum – No vertical datum codes are currently defined by the GeoTIFF specification, other than those implied by the corrsponding vertical coordinate system code. This profile limits the vertical datum to the WGS84 ellipsoid, the WGS-84 Earth Gravity Field Model (EGM 84, 96 or 2008), and hydrographic datums, when required. Note that the Earth Gravity Field Model will provide an approximation of Mean Sea Level.

Coordinate systems – GeoTIFF allows many geographic latitude-longitude systems and many projected coordinate systems. There are also tags for parameters of coordinate systems or projections not available in the codes. This profile limits expression of coordinate references to WGS84 latitude and longitude (decimal degrees) and the UTM Grid System Northing and Easting (meters).

### 7.9 Collection and Maintenance Constraints

There are several TIFF tags that can carry and address a variety of collection information. These tags should not be populated for the purpose of this format representation. The associated XML metadata expression can optionally be used to carry this type of information when needed.

### 7.10 Tiling of TIFF/GeoTIFF

It is common industry practice for range value records within imagery or gridded data collections to be organized into tiles. The three primary motivations for organizing range value records into a tiling scheme are: 1) The nature and description of the value records within the collection or dataset is different, thus requiring different metadata descriptions; 2) The physical size of the range value data is so large that it warrants subdivision for ease of data management; and 3) The sampling density varies within the coverage of the dataset.

In contrast to the above use of the term ‘tile’ wherein the data for each tile is typically stored within separate files, TIFF supports an internal tiling structure that addresses the sequence and interleave of range values within an array internal to the TIFF file. Internal tiling is a distinct concept from external tiling, and both types may be used within a dataset. The terms ‘TIFF tile’ (internal) and ‘metadata tile’ (external) are independent of each other.and any correlation between the external and internal tiles is coincidental or by design.

External tile boundaries must be defined with geographic locations because metadata boundaries may be independent of the external tile boundaries and subsets of the dataset must be allowed to include all relevant metadata.

GeoTIFF specific keys do not contain a place to address internal tiling, so all internal tiling information is contained in the TIFF tags. The TIFF and GeoTIFF formats have no means to describe external tiling, so the associated XML metadata expression is available to meet this need.

This profile places no constraints for how an imagery and gridded data collection or dataset is organized into external tiles. A very common external tile size is the 1536 x 1536 frame size currently use by data organized per the Raster Product Format (RPF) specification. Each 1536 x 1536 external tile is stored in a separate frame file that is internally organized as thirty-six 256 x 256 internal tiles.

For internal tiling, this profile allows use of either the TIFF ‘strip’ approach or the TIFF internal tiling approach. Generally, for small grids, the data should be organized as a single TIFF tile within the file. For large grids (greater than 8192 x 8192), the recommended TIFF tile size is 1024 x 1024. When opting to use internal tiles, the range value data may need to be padded to tile boundaries when the grid size is not an integer multiple of the selected tile size.

### 7.11 Number of Bands

The number of bands within a GeoTIFF grid is constrained to be either 1-band, 3-bands, or 4-bands. For the 3 and 4-band cases, the band interleave shall be the TIFF ‘chunky’ format (band interleaved by pixel).

### 7.12 Range Value Data Types and Precision

For imagery, the range (data) values are constrained to be unsigned integer data, 8 or 16-bits-per-band.

A 1-bit bi-level transparency mask is also allowed. The transparency mask is specified by a second IFD (see Section 7.1), and is perfectly superposable to the image data specified by first IFD. In the transparency mask, a value of 1 indicates a significant pixel whereas a value of 0 indicates a padding pixel that should be rendered as transparent. A transparency mask contains no GeoTIFF tags.

For gridded data (e.g. elevation data, matrices of lat/lon values, etc.), the range values may be stored in additional representations to include 8-bit and 16-bit signed integer and 32-bit floating point. For integer values, the MaxSampleValue and MinSampleValue TIFF tags identify the extent of the value range. For floating point (real) number values, the SminSampleValue and SmaxSampleValue tags are used.

### 7.13 Compression Options

This profile requires that the GeoTIFF range values be uncompressed. Requirements for compressed imagery must be satisfied in formats other than GeoTIFF. Data compaction techniques (such as adjusting sampling frequency) are left to the discretion of the implementer in light of the intended use of the data and associated quality requirements.

### 7.14 File Naming

This profile places no constraints for naming GeoTIFF files. An example naming convention for illustration purposes is:

Sensor Name + ULLong + ULLat + Acquisition Date + Acquisition Time.TIF

Sensor Name = 10 Char
Upper Left Long Coordinate (ULLong) = +/- (for hemisphere) three digit degree & eight digit decimal (Decimal Degree format)
Upper Left Lat Coordinate (ULLat) = +/- (for hemisphere) two digit degree & eight digit decimal (Decimal Degree format)
Acquisition Date = YYYYMMDD
Acquisition Time = hhhhmmss

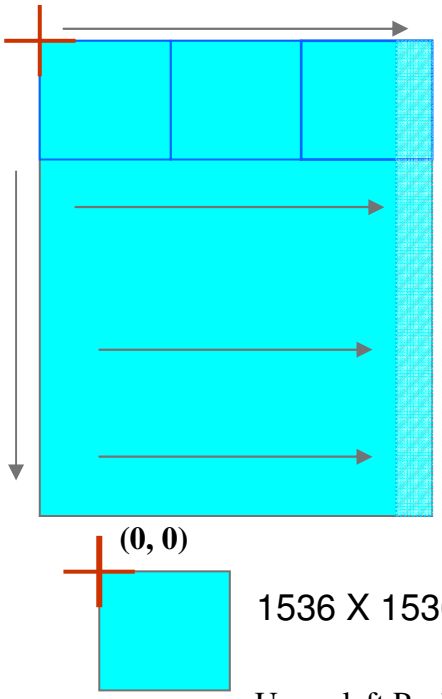
Example: SensorX01_-022.78987654_+30.78654321_20040209_13002028.tif

### 7.15 Tiling (Framing) Conventions

This profile places no constraints on conventions for organizing a large coverage into an external tiling (otherwise known as framing) scheme. An example framing method/practice for consideration is to follow the 1536 x 1536 external tiling approach described in 7.10.

The image framing orientation is defined by designating the position of origin as the upper left corner (the first image pixel) of the coverage to be externally tiled. Frames are calculated from the orientation position (0, 0) then calculate frame size by the selected tile size (e.g. 1536). Frames are numbered 1 through N, by the calculated extent of the image size or number of pixels in X and Y. Number schema sequencing is left to right in X, then back to the X origin position = 0 and a Y position = to the tile size + 1 to begin the next row of frames. If the number of frame pixels is not complete, pixels must be padded to fill the frame. See Frame Diagram 7.15.1.

This profile recommends frame file naming conventions follow GeoTIFF file naming conventions. Frame files should be identified in the same format with the frame sequence number added as part of the file name. Example for frame 1 (using 7.14 file naming example): SensorX01_-022.78987654_+30.78654321_20040209_13002028_1.tif.




**Pad Pixels**

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | 9 |
| 10 | 11 | 12 |

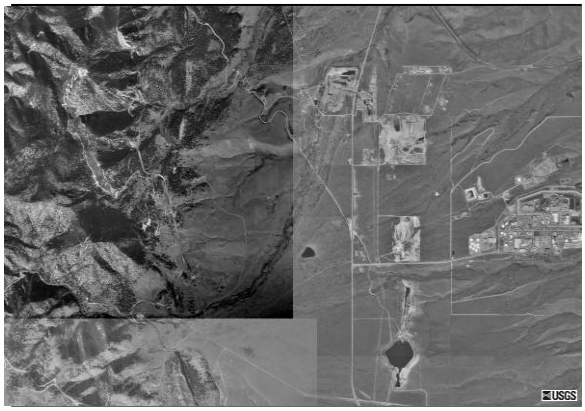
**Image pixel dimensions determines the number of rows and columns to 1536 x 1536 tile size (3 X4) and numbers by rows, and begins each next sequence number starting at the left of each row.**

Frame Diagram 7.15.1

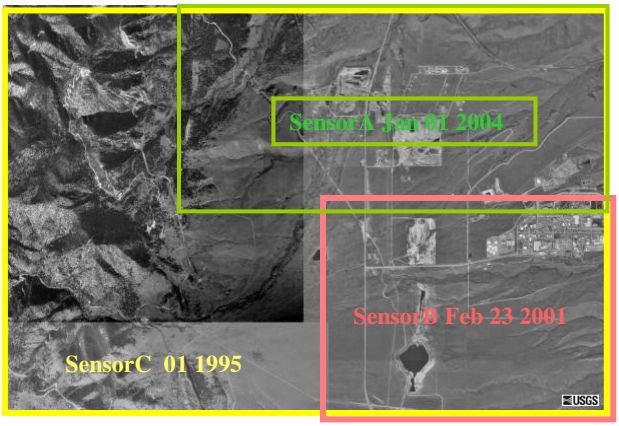
### 7.16 Mosaic Image

This profile addresses GeoTIFF mosaics and the association of metadata for GeoTIFF mosaic images composed of supplemental image files compositely merged together to form a mosaic image. See Mosaic Diagram 7.16.1.

The method to associate parameters and metadata for each image used to compose the mosaic will be addressed in the Supplemental Associated Metadata section 7.17.




GEOTIFF
Mosaic




GEOTIFF
Imagery Coverage

Diagram 7.16.1: GeoTIFF Mosaic

The imagery coverage diagram on the right shows that metadata is described in relation to geographic areas, and not necessarily to scene boundaries.

## 7.17 Supplemental Associated Metadata

This profile addresses TIFF/GeoTIFF metadata shortfalls to support NSG fundamental imagery metadata requirements. This profile allows additional metadata to be embedded within the GeoTIFF file, or to be provided as an external file. The use of any private TIFF or GeoTIFF tags, other than those included in Appendix A, is prohibited by this profile. Additional metadata that may be required by the producer should be included only in the supplemental metadata.

The supplemental associated metadata follows the NSG Core Metadata Profile (NGCMP) and the ISO 19115 metadata model (see Appendix B.1). The supplemental set of associated metadata accommodates individual and multi-composite (mosaic) GeoTIFF files. A Private TIFF Geo_Metadata tag has been created to support the additional metadata information, see GEO_METADATA TIFF Tag Diagram 7.17.1.

*Note: Should a conflict exists between the information provided in the baseline TIFF/GeoTIFF metadata and the supplemental metadata, this profile sets no precedence between the two, and the inconsistency is left to be addressed by the user or interpreting software.*

| **IFD** | | Image File Directory |
|---|---|---|
| **Code** | | 50909 (hex 0x87AF) |
| **Name** | | Geo_Metadata |
| **Type** | | ASCII |
| **Count** | | 4-byte (max. size = 4GB) |
| **Default** | | None |

Diagram 7.17.1: Registered TIFF Private GEO_METADATA

# Appendix A – Format Constraints

## A.1 TIFF Format

The file structure for the Image File Header and Image File Directory can be found in the TIFF product specification in Part 1, Section 2: TIFF Structure. There are four Baseline TIFF image types – bilevel, grayscale, palette-color, and full-color images. Each type has specific field requirements, and these can be found in Sections 3 through 5 of the TIFF document. For the purpose of representing imagery, the grayscale and full-color image baselines are appropriate. For the purpose of representing gridded data (e.g. elevation data values) in GeoTIFF, none of the Baseline TIFF image types directly apply, however, this implementation profile is still based upon the Baseline TIFF Fields with only a few additional or extension fields. The use of any private tags, other than those included in this appendix, is prohibited by this profile. Additional metadata that may be required by the producer should be included only in the supplemental metadata.

Table A.1 describes the baseline fields defined in the TIFF specification, version 6.0, and is adapted from Section 8: Baseline Field Reference Guide. Table 1 also includes the additional TIFF fields and extensions needed to support the profile; an asterisk next to the tag number indicates such fields. TIFF format-specific notes and definitions have been left out of this table and can be found in the TIFF specification, revision 6.0. This table includes, where applicable, the equivalent supplemental metadata association and the related element(s) from the NSG Geospatial Core Metadata Profile (NGCMP) and the ISO 19115 metadata model.

**Table A.1: TIFF Fields**

(from Section 8: Baseline Field Reference Guide)

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| Artist (R) | Person who created the image.<br><br>For Profile: Populate with the name of the organization responsible for the file. | 315 | ASCII | resource originator | MD_identification.pointOfContact.CI_ResponsibleParty.organizationName<br><br>MD_identification.pointOfContact.CI_ResponsibleParty.role |
| BitsPerSample (R) | Number of bits per component.<br><br>For Profile: Set to the number of bits used to represent each range (sample) value.<br>For imagery, constrained to 8 and 16-bits-per-pixel-per-band. For other gridded data, constrained to 8, 16 and 32 bits per range (sample) value. For a transparency mask, set = 1. | 258 | SHORT | N/A | MD_ContentInformation<br>MD_CoverageDescription<br>MD_RangeDimension<br>MD_Band.bitsPerValue |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| CellLength (N) | The length of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file. | 265 | SHORT | N/A | N/A |
| CellWidth (N) | The width of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file. | 264 | SHORT | N/A | N/A |
| ColorMap (C) | Defines an RGB color map (lookup table) for palette color images. Number of values = 3 * (2**BitsPerSample) | 320 | SHORT | N/A | N/A |
| Compression (O) | Compression scheme used on the image data.<br><br>For Profile: Desired but optional: Use a value of 1 designating the range value data is not compressed. (D) | 259 | SHORT | N/A | (MD_Distribution, MD_Identification, and MD_Distributor) MD_Format.fileDecompressionTechnique |
| Copyright (R) | Copyright notice.<br><br>For Profile: When access or usage restrictions (or both) exist for the dataset, populate with the applicable copyright notice of the person or organization that claims the copyright to the image. The complete copyright statement shall be listed in this field including any dates and statements of claims. If no usage restrictions exist, it shall be so stated in this field. | 33432 | ASCII | Rights | MD_LegalConstraints.accessConstraints<br><br>MD_Legal Constraints.useConstraints |
| DateTime (R) | Date and time of image creation.<br><br>For Profile: The date and time that most closely reflects the currency of the data range values. | 306 | ASCII | (image) acquisition date | MD_Identification.citation.CI_Citation.date |
| ExtraSamples (C) | Description of extra components.<br>For Profile: Populate with a value of 1 for 4-band images | 338 | SHORT | N/A | N/A |
| FillOrder (O) | The logical order of bits within a byte.<br><br>For Profile:<br>Desired but optional. Use a value of 1 (D). | 266 | SHORT | N/A | N/A |
| FreeByteCounts (N) | For each string of contiguous unused bytes in a TIFF file, the number of bytes in the string. | 289 | LONG | N/A | N/A |
| FreeOffsets (N) | For each string of contiguous unused bytes in a TIFF file, the byte offset of the string. | 288 | LONG | N/A | N/A |
| GrayResponseCurve (N) | For grayscale data, the optical density of each possible pixel value. | 291 | SHORT | N/A | N/A |
| GrayResponseUnit (N) | The precision of the information contained in the GrayResponseCurve. | 290 | SHORT | N/A | N/A |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| HostComputer (O) | Identification of the hardware/software used in formulation of the image.<br><br>For Profile: Optional, but not desired.<br>Populate with identification of the system used to process/create the range values from the raw instrument data or other source of sample data.<br>Example: Integrated Exploitation Capability (IEC) workstation | 316 | ASCII | N/A | N/A |
| ImageDescription (R) | A string that describes the subject of the image.<br><br>For Profile:<br>Populate with security marking for the image data and provide abstract description formatted as follows;<br><br>SECURITY BANNER:<br>(CAPCO security marking information as free text)<br><br>ABSTRACT:<br>(resource abstract information (e.g. location, topic) as free text; for muti-band case, identify the bands by name) | 270 | ASCII | resource abstract | MD_Metadata >MD_DataIdentification.abstract |
| ImageLength (R) | The number of rows of pixels in the image.<br><br>For Profile:<br>The number of rows of range values in the grid.<br><br>Note that for GeoTIFF, there is no means to designate that only part of the grid contains meaningful range values. | 257 | SHORT or LONG | N/A | MD_Metadata.spatialRepresentationInfo.MD_ GridSpatialRepresentation.axisDimensionProperties. MD_Dimension.dimensionName<br><br>AND<br><br>MD_Metadata.spatialRepresentationInfo.MD_ GridSpatialRepresentation.axisDimensionProperties. MD_Dimension.dimensionSize |
| ImageWidth (R) | The number of columns in the image, i.e. the number of pixels per row.<br><br>For Profile:<br>The number of columns of range values in the grid.<br><br>Note that for GeoTIFF, there is no means to designate that only part of the grid contains range values. | 256 | SHORT or LONG | N/A | MD_Metadata.spatialRepresentationInfo.MD_ GridSpatialRepresentation.axisDimensionProperties. MD_Dimension.dimensionName<br><br>AND<br><br>MD_Metadata.spatialRepresentationInfo.MD_ GridSpatialRepresentation.axisDimensionProperties. MD_Dimension.dimensionSize |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| Make (R) | The scanner manufacturer.<br><br>For Profile:<br>The manufacturer of the instrument used to obtain the rangevalues. | 271 | ASCII | sensor name | MI_Instrument.citation.MI_Instrument.description |
| MaxSampleValue (C) | The maximum component value used.<br>Required for Integer case | 281 | SHORT | N/A | N/A |
| MinSampleValue (C) | The minimum component value used.<br>Required for integer case | 280 | SHORT | N/A | N/A |
| Model (R) | The scanner model name or number.<br><br>For Profile:<br>The manufacturer's model name or number of the instrument used to obtain the range values. | 272 | ASCII | sensor name | MI_Instrument.citation.MI_Instrument.description |
| NewSubfileType (C) | A general indication of the kind of data contained in this subfile.<br>For Profile:<br>Bit 2 is set =1 when the data is a transparency mask | 254 | LONG | N/A | N/A |
| Orientation (O) | The orientation of the image with respect to the rows and columns.<br><br>For Profile:<br>Desired but optional: Set this value to the default (D) value of 1. Orientation of the grid indices to the external coordinate reference system is defined by the GeoTIFF tags. | 274 | SHORT | N/A | N/A |
| PhotometricInterpretation (R) | The color space of the image data.<br><br>For Profile:<br>Allowed values are:<br>1- Black is zero<br>2- RGB<br>3- Palette Color<br>4- Transparency Mask<br>Note: A value for the 4-band case is not defined in the TIFF specification. In the 4-band case, use a value of 2 and populate the ExtraSamples tag with a value of 1. | 262 | SHORT | N/A | N/A |
| PlanarConfiguration (C) | How the components of each pixel are stored.<br><br>For Profile:<br>When more than one band is described by the range values, Include this tag and set the value to 1 (chunky format). | 284 | SHORT | N/A | N/A |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| ResolutionUnit (R) | The unit of measurement for XResolution and YResolution.<br><br>For Profile:<br>Set equal to 2 (inches) (D) . | 296 | SHORT | N/A | N/A |
| RowsPerStrip (C) | The number of rows per strip.<br>**Not used if Tiling has been used.**<br><br>For Profile:<br>The TIFF specification recommends selecting the value for RowsPerStrip such that each strip is about 8K bytes; it makes buffering simpler for readers. | 278 | SHORT or LONG | N/A | N/A |
| SampleFormat (R) | This field specifies how to interpret each data sample in a pixel. Possible values are:<br>1 = unsigned integer data<br>2 = two's complement signed integer data<br>3 = IEEE floating point data [IEEE]<br><br>This field does not specify the size of data samples; the BitsPerSample field does this.<br><br>For Profile:<br>Select the value corresponding to the sample format used for representing the range (data) values. | 339* | SHORT | N/A | Coverage.rangeType (ISO 19123) |
| SamplesPerPixel (R) | The number of components per pixel.<br><br>For Profile:<br>Allowed values are 1 (monochrome or transparency mask), 3 (RGB) and 4 (4-band data). | 277 | SHORT | N/A | Coverage.rangeType (19123) |
| SminSampleValue (C) | The minimum sample value. This tag is used in lieu of MinSampleValue when the sample type is other than integer.<br><br>For Profile:<br>The minimum component value used. | 340* | The field type that best matches the sample data | N/A | N/A |
| SmaxSampleValue (C) | The maximum sample value. . This tag is used in lieu of MaxSampleValue when the sample type is other than integer.<br><br>For Profile:<br>The maximum component value used. | 341* | The field type that best matches the sample data | N/A | N/A |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| Software (R) | Name and version number of the software packages(s) used to create the image.<br><br>For Profile:<br>Populate with descriptor of the software package(s) used to process/create the range values from the raw instrument data or other source of imagery and gridded data. | 305 | ASCII | N/A | N/A |
| StripByteCounts (C) | For each strip, the number of bytes in the strip after compression.<br>**Not used if Tiling has been used.**<br><br>For Profile:<br>Populate per TIFF specification when opting to use strips. | 279 | SHORT or LONG | N/A | N/A |
| StripOffsets (C) | For each strip, the byte offset of that strip. **Not used if Tiling has been used.**<br><br>For Profile:<br>Populate per TIFF specification when opting to use strips. | 273 | SHORT or LONG | N/A | N/A |
| SubfileType (N) | A general indication of the kind of data contained in this subfile. | 255 | SHORT | N/A | N/A |
| Thresholding (O) | For black and white TIFF files that represent shades of gray, the technique used to convert from gray to black and white pixels.<br><br>For Profile: Desired but optional:<br>Set to 1. (D) | 263 | SHORT | N/A | N/A |
| TileWidth (C) | The tile width in pixels. This is the number of columns in each tile.<br><br>For Profile:<br>Populate per TIFF specification when opting to use internal tiles | 322* | Short or Long | N/A | N/A |
| TileLength (C) | The tile length (height) in pixels. This is the number of rows in each tile.<br><br>For Profile:<br>Populate per TIFF specification when opting to use internal tiles | 323* | Short or Long | N/A | N/A |

| **Field**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description**<br>**(D) – Must use the default value** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A = Not Addressed | **19115 Metadata Element**<br>N/A = Not Addressed |
|---|---|---|---|---|---|
| TileOffsets (C) | For each tile, the byte offset of that tile, as compressed and stored on disk.<br><br>For Profile:<br>Populate per TIFF specification when opting to use internal tiles | 324* | Long | N/A | N/A |
| TileByteCounts (C) | For each tile, the number of (compressed) bytes in that tile.<br><br>For Profile:<br>Populate when internal tiling is used. | 325* | Short or Long | N/A | N/A |
| XResolution (R) | The number of pixels per ResolutionUnit in the ImageWidth direction.<br>For Profile: populate with intended display resolution | 282 | RATIONAL | N/A | N/A |
| YResolution (R) | The number of pixels per ResolutionUnit in the ImageLength direction.<br>For Profile: populate with intended display resolution | 283 | RATIONAL | N/A | N/A |
| GDAL_NODATA (C) | An ASCII value intended to specify what pixel value is being used to represent missing or background data.<br>For Profile: Populate with the value that represents void areas. | 42113 | ASCII | N/A | N/A |
| Geo_Metadata (C) | Additional Geographic metadata information (when opting to place it internal to GeoTIFF file) | 50909 | ASCII | supplementary metadata as defined by the XML schema | N/A |

## A.2 GeoTIFF data format

All of the GeoTIFF information is encoded in six tags, and numerous keys are available to store projection parameters and coordinate system information. Use of keys and parameters is constrained as indicated within this profile. All keys are referenced from one tag, the GeoKeyDirectoryTag. The following information is from the GeoTIFF product specification, Revision 1.0, in Section 1: Baseline GeoTIFF. Specific definitions, formats, and codes can be found in GeoTIFF Format Specification, Revision 1.0. The tables located in A.2.1 through A.2.4 include, where applicable, reference to the related ISO 191115 metadata element.
As with baseline TIFF tags, the use of any private GeoTIFF tags is prohibited by this profile. Additional metadata that may be required by the producer should be included only in the supplemental metadata.

## Table A.2: GeoTIFF Tags

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| GeoKeyDirectoryTag (R) | Stores GeoKey Directory, which defines and references the "GeoKeys." All Keys in GeoTIFF are referenced from the GeoKeyDirectoryTag | 34735 | SHORT | N/A | N/A |
| GeoDoubleParamsTag (N) | Used to store all of the DOUBLE valued GeoKeys, referenced by the GeoKeyDirectoryTag<br>For Profile: Do not use this tag, it is unnecessary because as all Double type GeoKeys are prohibited by this profile. | 34736 | DOUBLE | N/A | N/A |
| GeoAsciiParamsTag (R) | Used to store all of the ASCII valued GeoKeys, referenced by the GeoKeyDirectoryTag | 34737 | ASCII | N/A | N/A |
| ModelTiepointTag (R) | Stores raster -> model tiepoint pairs in the order ModelTiepointTag = (…,I,J,K, X,Y,Z…) where (I,J,K) is the point at location (I,J) in raster space with pixel-value K, and (X,Y,Z) is a vector in model space. The Z value is an offset used in conjuction with the Z pixel scale (tag 33550) to position the data vertically.<br><br>For Profile:<br>Populate this tag with the tie point pair that correlates to the grid origin (grid coordinates 0,0)<br>For imagery and typical elevation data (no offset), set Z=0 | 33922 | DOUBLE | N/A | Grid.Origin.DirectPosition.coordinate (ISO 19123)<br><br>MD_Dataidentification.extent.EX_BoundingPolygon.polygon.GM_Polygon.boundary.GM_SurfaceBoundary.exterior (ISO 19107) |
| ModelPixelScaleTag (R) | Used to specify the size of raster pixel spacing in the model space units, consists of the following three values ModelPixelScaleTag = (ScaleX, ScaleY, ScaleZ)<br><br>For Profile:<br>Populate per GeoTIFF specification;<br>For imagery, set Z=0, for elevation data, set Z=1<br>Note: This tag must not be used if the image requires rotation. | 33550 | DOUBLE | N/A | Grid.offsetVectors.Vector.dimension (ISO 19123) |
| ModelTransformationTag (C) | Used to specify the transformation matrix between the raster space and the model space, it has the following organization:<br>ModelTransformationTag = (a,b,c,d,e,….,m,n,o,p)<br><br>For Profile:<br>Use this tag when the image requires rotation in order to be north-oriented. | 34264 | DOUBLE | N/A | N/A |

### A.2.1 GeoTIFF Configuration GeoKeys

These keys are to be used to establish the general configuration of a file's coordinate system, including the types of raster coordinate systems, model coordinate systems, and citations if any.

**Table A.2.1: GeoTIFF Configuration GeoKeys**

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| GTModelTypeGeoKey (R) | Defines general type of model coordinate system used, and to which the raster space will be transformed.<br><br>For Profile: The applicable codes are:<br>1 – ModelTypeProjected<br>2 – ModelTypeGeographic | 1024 | SHORT | reference system | MD_ReferenceSystem.<br>ReferenceSystemIdentifier.RS_identifer<br>.code |
| GTRasterTypeGeoKey (R) | Establishes the raster space coordinate system – RasterPixelIsPoint, RasterPixelIsArea.<br><br>For Profile: The applicable codes are:<br>1 - RasterPixelIsArea<br>2 – RasterPixelIsPoint | 1025 | 6.3.1.2 codes | N/A | N/A |
| GTCitationGeoKey (R) | Provided to give an ASCII reference to published documentation on the overall configuration of this GeoTIFF file.<br><br>For Profile: The ASCII value for this key is: GeoTIFF Revision 1.0, Version 1.8.2, Implementation Profile Version 1.0, *FormatSpecification* (detailed product specification, if any, used to define this GeoTIFF file). | 1026 | ASCII | distribution format | MD_Format.name<br>MD_Format.version<br>MD_Format.specification |

### A.2.2 Geographic CS Parameter Keys

In general, the coordinate system used will be implied by the projected coordinate system code (Table A.2.3). However, If the model type was chosen to be Geographic (GTModelTypeGeoKey = 2), then the system must be explicitly defined with the following keys.

## Table A.2.2: Geographic CS Parameter Keys

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| GeographicTypeGeoKey (C) | This key may be used to specify the code for the geographic coordinate system used to map lat-long to a specific ellipsoid over the earth.<br><br>For Profile:<br>4326 – GCS_WGS84<br>4030 – GCSE_WGS84 | 2048 | SHORT<br><br>(Code from Section 6.3.2.1) | reference System | MD_ReferenceSystem.<br>ReferenceSystemIdentifier.RS_identifer<br>.code |
| GeogCitationGeoKey (C) | This key provides a general citation and reference for all Geographic CS parameters.<br><br>For Profile:<br>The ASCII value for this key is:<br>WGS84 [DMA TR 8350.2] | 2049 | ASCII | N/A | N/A |
| GeogGeodeticDatumGeoKey (N) | This key may be used to specify the horizontal datum, defining the size, position and orientation of the reference ellipsoid used in userdefined geographic coordinate systems.<br><br>For Profile: Do not use this key. | 2050 | SHORT<br><br>(code from Section 6.3.2.2) | N/A | N/A |
| GeogPrimeMeridianGeoKey (N) | This key allows specification of the location of the Prime meridian for user-defined Geographic coordinate systems. The default standard is Greenwich, England.<br><br>For Profile:<br>Do not use this key. | 2051 | SHORT<br><br>(Code from Section 6.3.2.4) | N/A | N/A |
| GeogLinearUnitsGeoKey (N) | This key allows the definition of geocentric CS linear units for user-defined GCS.<br><br>For Profile:<br>Do not use this key. | 2052 | DOUBLE<br><br>Code from Section 6.3.1.3) | N/A | N/A |
| GeogLinearUnitSizeGeoKey (N) | Allows the definition of user-defined linear geocentric units, as measured in meters.<br><br>For Profile:<br>Do not use this key. | 2053 | DOUBLE | N/A | N/A |

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| GeogAngularUnitsGeoKey (N) | This key Allows the definition of **geocentric** CS Linear units for user-defined GCS and for ellipsoids.<br><br>For Profile:<br>Do not use this key. | 2054 | SHORT<br><br>(Code from Section 6.3.1.4) | N/A | N/A |
| GeogAngularUnitSizeGeoKey (N) | Allows the definition of user-defined angular geographic units, as measured in radians.<br><br>For Profile:<br>Do not use this key. | 2055 | DOUBLE | N/A | N/A |
| GeogEllipsoidGeoKey (N) | This key may be used to specify the coded ellipsoid used in the geodetic datum of the Geographic Coordinate System.<br><br>For Profile:<br>Do not use this key. | 2056 | SHORT<br><br>(Code from Section 6.3.2.3) | N/A | N/A |
| GeogSemiMajorAxisGeoKey (N) | This key allows the specification of user-defined Ellipsoid Semi-Major Axis (a).<br><br>For Profile:<br>Do not use this key. | 2057 | DOUBLE | N/A | N/A |
| GeogSemiMinorAxisGeoKey (N) | This key allows the specification of user-defined Ellipsoid Semi-Minor Axis (b).<br><br>For Profile:<br>Do not use this key. | 2058 | DOUBLE | N/A | N/A |
| GeogInvFlatteningGeoKey (N) | This key Allows the specification of the **inverse** of user-defined Ellipsoid's flattening parameter (f).<br><br>For Profile:<br>Do not use this key. | 2059 | DOUBLE | N/A | N/A |
| GeogAzimuthUnitsGeoKey (N) | This key This key may be used to specify the angular units of measurement used to defining azimuths, in geographic coordinate systems. These may be used for defining azimuthal parameters for some projection algorithms, and may not necessarily be the same angular units used for lat-long.<br><br>For Profile:<br>Do not use this key. | 2060 | SHORT<br><br>(Codes from Section 6.3.1.4) | N/A | N/A |

| GeoTIFF Tag<br>(R) – Required<br>(N) – Do Not Use<br>(C) – Conditional | Description | Tag | Type | Metadata Association in NGMCP<br>N/A – Not Addressed | 19115 Metadata Element<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| GeogPrimeMeridianLongGeoKey (N) | This key allows definition of user-defined Prime Meridians, the location of which is defined by its longitude relative to Greenwich.<br><br>For Profile:<br>Do not use this key. | 2061 | DOUBLE | N/A | N/A |

### A.2.3 Projected CS Parameter Keys

**Table A.2.3: Projected CS Parameter Keys**

| GeoTIFF Tag<br>(R) – Required<br>(N) – Do Not Use<br>(C) – Conditional | Description | Tag | Type | Metadata Association in NGMCP<br>N/A – Not Addressed | 19115 Metadata Element<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| ProjectedCSTypeGeoKey (C) | This code is provided to specify the projected coordinate system.<br><br>For Profile:<br>326zz – UTM Northern Hemisphere<br><br>327zz – UTM Southern Hemisphere<br><br>Where zz is the UTM zone number. | 3072 | SHORT<br><br>(Code from Section 6.3.3.1) | reference system | MD_ReferenceSystem.<br>ReferenceSystemIdentifier.RS_identifer<br>.code |
| PCSCitationGeoKey (C) | This key is provided to give an ASCII reference to published documentation on the Projected Coordinate System.<br><br>For Profile:<br>The ASCII value for this key is:<br>'UTM Grid System [NIMA TM 8358.2]'<br>and<br>'Note: units (meters) are implicit in the CS Type' | 3073 | ASCII | N/A | N/A |
| ProjectionGeoKey (N) | This key allows specification of the coordinate transformation method and projection zone parameters.<br><br>For Profile:<br>Do not use this key. | 3074 | SHORT<br><br>(Code from Section 6.3.3.2) | N/A | N/A |

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| ProjCoordTransGeoKey (N) | This key allows specification of the coordinate transformation method used.<br><br>For Profile:<br>Do not use this key. | 3075 | SHORT<br><br>(Code from Section 6.3.3.3) | N/A | N/A |
| ProjLinearUnitsGeoKey (N) | This key defines the linear units used by the projection<br><br>For Profile:<br>Do not use this key | 3076 | SHORT<br><br>(Code from Section 6.3.1.3) | N/A | N/A |
| ProjLinearUnitSizeGeoKey (N) | This key defined the size of user-defined linear units in meters.<br><br>For Profile:<br>Do not use this key. | 3077 | DOUBLE | N/A | N/A |
| ProjStdParallel1GeoKey (N) | This key specifies the latitude of the primary standard parallel.<br><br>For Profile:<br>Do not use this key. | 3078 | DOUBLE | N/A | N/A |
| ProjStdParallel2GeoKey (N) | This key specifies the latitude of the second standard parallel.<br><br>For Profile:<br>Do not use this key. | 3079 | DOUBLE | N/A | N/A |
| ProjNatOriginLongGeoKey (N) | This key defines the longitude of the map projection natural origin.<br><br>For Profile:<br>Do not use this key. | 3080 | DOUBLE | N/A | N/A |
| ProjNatOriginLatGeoKey (N) | This key defines the latitude of the map projection natural origin.<br><br>For Profile:<br>Do not use this key. | 3081 | DOUBLE | N/A | N/A |
| ProjFalseEastingGeoKey (N) | This key provides the easting coordinate of the map projection natural origin.<br><br>For Profile:<br>Do not use this key. | 3082 | DOUBLE | N/A | N/A |
| ProjFalseNorthingGeoKey (N) | This key provides the northing coordinate of the map projection natural origin.<br><br>For Profile:<br>Do not use this key. | 3083 | DOUBLE | N/A | N/A |

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| ProjFalseOriginLongGeoKey (N) | This key provides the longitude of the false origin.<br><br>For Profile:<br>Do not use this key. | 3084 | DOUBLE | N/A | N/A |
| ProjFalseOriginLatGeoKey (N) | This key provides the latitude of the false origin<br><br>For Profile:<br>Do not use this key. | 3085 | DOUBLE | N/A | N/A |
| ProjFalseOriginEastingGeoKey (N) | This key provides the easting coordinate of the false origin.<br><br>For Profile:<br>Do not use this key. | 3086 | DOUBLE | N/A | N/A |
| ProjFalseOriginNorthingGeoKey (N) | This key provides the northing coordinate of the false origin.<br><br>For Profile:<br>Do not use this key. | 3087 | DOUBLE | N/A | N/A |
| ProjCenterLongGeoKey (N) | This key provides the longitude of the center of the projection (not necessarily the origin).<br><br>For Profile:<br>Do not use this key. | 3088 | DOUBLE | N/A | N/A |
| ProjCenterLatGeoKey (N) | This key provides the latitude of the center of the projection (not necessarily the origin).<br><br>For Profile:<br>Do not use this key. | 3089 | DOUBLE | N/A | N/A |
| ProjCenterEastingGeoKey (N) | This key provides the easting coordinate of the center.<br><br>For Profile:<br>Do not use this key. | 3090 | DOUBLE | N/A | N/A |
| ProjCenterNorthingGeoKey (N) | This key provides the northing coordinate of the center.<br><br>For Profile:<br>Do not use this key. | 3091 | DOUBLE | N/A | N/A |
| ProjScaleAtNatOriginGeoKey (N) | This key provides the scale at the natural origin as a ratio.<br><br>For Profile:<br>Do not use this key. | 3092 | DOUBLE | N/A | N/A |

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| ProjScaleAtCenterGeoKey (N) | This key provides the scale at the projection center as a ratio.<br><br>For Profile:<br>Do not use this key. | 3093 | DOUBLE | N/A | N/A |
| ProjAzimuthAngleGeoKey (N) | This key provides the azimuth angle east of true north of the central line passing through the projection center.<br><br>For Profile:<br>Do not use this key. | 3094 | DOUBLE | N/A | N/A |
| ProjStraightVertPoleLongGeoKey (N) | This key provides the longitude at the straight vertical pole for Polar Stereographic projections.<br><br>For Profile:<br>Do not use this key. | 3095 | DOUBLE | N/A | N/A |

### A.2.4 Vertical CS Parameter Keys

**Table A.2.4: Vertical CS Parameter Keys**

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| VerticalCSTypeGeoKey (C) | This key may be used to specify the vertical coordinate system.<br><br>For Profile:<br>5030 – WGS_84_ellipsoid<br>5171 – EGM96 geoid<br>5203 – EGM84 geoid<br>32767 – user defined<br><br>Note: The 'user defined' code shall be used for the EGM 2008 geoid case, or when using a hydrographic datum. The VerticalCitationGeoKey shall be used to identify the coordinate system/datum for the user defined case, | 4096 | SHORT<br><br>(Code from Section 6.3.4.1) | reference system | MD_ReferenceSystem.<br>ReferenceSystemIdentifier.RS_identifer<br>.code |

| **GeoTIFF Tag**<br>**(R) – Required**<br>**(N) – Do Not Use**<br>**(C) – Conditional** | **Description** | **Tag** | **Type** | **Metadata Association in NGMCP**<br>N/A – Not Addressed | **19115 Metadata Element**<br>N/A – Not Addressed |
|---|---|---|---|---|---|
| VerticalCitationGeoKey (C) | This key may be used to document the vertical coordinate system used, and its parameters.<br><br>For Profile:<br>Valid ASCII values for this key are:<br>WGS84 Ellipsoid [NIMA TR8350.2]<br>EGM84/96 [NIMA TR8350.2]<br>EGM 2008 [http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/index.html ]<br>(hydrographic datum name): [IHO S-57] | 4097 | ASCII | N/A | N/A |
| VerticalDatumGeoKey (N) | This key may be used to specify the vertical datum for the vertical coordinate system.<br><br>For Profile:<br>Do not use this key.<br><br>Note: There are no established codes for this key. | 4098 | SHORT<br><br>(Codes from Section 6.3.4.2) | N/A | N/A |
| VerticalUnitsGeoKey (C) | This key may be used to specify the vertical units of measurement used in the geographic coordinate system, in cases where geographic CS's needs to reference the vertical coordinate. This, together with the Citation key, comprises the only fully implemented keys in this section, at present.<br><br>For Profile:<br>9001 – Linear_Meter | 4099 | SHORT<br><br>(Code from Section 6.3.1.3) | N/A | EX_Verticalextent.unitOfMeasure |

# Appendix B – Supplemental Metadata

## B.1 Metadata Elements for Use with GeoTIFF Formatted Files

Since the popular use of TIFF/GeoTIFF does not adequately support expression of metadata, supplemental metadata to be associated with each GeoTIFF file is required by the NSG. The supplemental metadata shall be expressed using XML encoding. The metadata may be embedded within the GeoTIFF file using the profile-designated private TIFF tag (50509), or may be carried external to the GeoTIFF file in one or more separate XML files. Some of the metadata elements listed in this appendix correspond with TIFF and GeoTIFF fields described in Appendix A. This redundancy is intentional, and will prevent certain information from becoming unavailable to the GeoTIFF consumer if an XML file of supplemental metadata were to become separated from the GeoTIFF file.

At the time this profile was prepared, the general forward-looking metadata standardization strategy for the NSG is to adopt the ISO TC211 1900-series of standards to the maximum extent possible, both at the conceptual level, and at the physical encoding level when using XML. The rationale is to allow the NSG to take advantage of open, standards-based commercial off-the-shelf (COTS) products and services that are being heavily influenced by ISO TC211 standards and open commercial consortia-developed specifications and activities. The desire is to minimize the impact of DoD/IC specifications on COTS developers. Even so, since the ISO 1900-series approach for addressing security-related metadata is inadequate to meet DoD/IC objectives for security, the TC211 data models and schemas must be augmented with the Intelligence Community Metadata Standard for Information Security Markings (IC ISM). As other DoD/IC-specific issues surface that impact deployment of the ISO 1900-series of standards, they will be dealt with on a case-by-case basis.

This profile cannot predict the detailed information content requirements for the supplemental metadata to be associated with GeoTIFF files for specific applications within the NSG. However, the DoD/IC and GEOINT communities are formulating core data description and discovery metadata specifications that address the minimum information content (vocabulary) required for inclusion in every type of GEOINT data. Implementers are cautioned that the minimum mandatory metadata elements listed in this profile, or in other metadata specifications, may not be sufficient to meet the functional and performance requirements for their intended use of GeoTIFF. Once implementers of this GeoTIFF profile have identified their metadata requirements, they shall apply the ISO 1900-series data models, data dictionaries and rules for extension.

This appendix provides an example of applying ISO TC211-based metadata to formulate a GeoTIFF-related conceptual metadata model for illustrative purposes. Tables B.1.1 and B.1.2 provide a conceptual description of the metadata requirements for this example. The NSG Geospatial Core Metadata Profile (NGCMP), version 1.0, August 2007, and the IC ISM, 15 August 2006, are the primary sources of information content requirements used for this example. Note that several elements in Table B.1.1 are not addressed in the NGCMP and that the Obligation/Condition statements and Domain restrictions in the table may address contraints beyond those in NGCMP. When an element in this table corresponds to an element listed in ISO 19115, Geographic Information – Metadata, the ISO 19115 core metadata name and hierarchal metadata schema path are included in the table using the notation approach shown in Table 3 of ISO 19115.

Appendix C provides information about ISO TC211 and IC ISM xml schema (.xsd) documents, and Appendix D provides a human-readable and XML instance example of supplemental metadata for a typical orthoimage.

**Table B.1.1: Supplemental Metadata**

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 1 | **resource title**<br><br>ISO: dataset title | Name by which the cited resource is known<br><br>MD_Metadata > MD_DataIdentification.citation > CI_Citation.title | Mandatory | 1 | Character String | Free Text |
| 2 | **resource date**<br><br>ISO: dataset reference date | Date for the cited resource<br><br>MD_Metadata > MD_DataIdentification.citation > CI_Citation.date > CI_Date | Mandatory | N | Compound | Row 2.1-2.2 |
| 2.1 | **resource date**<br><br>ISO: date | Date for the cited resource<br><br>MD_Metadata > MD_DataIdentification.citation > CI_Citation.date > CI_Date.date | Mandatory | 1 | Class | Date |
| 2.2 | **resource date type**<br><br>ISO: date | Event used for the date<br><br>MD_Metadata > MD_DataIdentification.citation > CI_Citation.date > CI_Date.dateType | Mandatory | 1 | Code | Table B.2.1 |
| 3 | **resource abstract**<br><br>ISO: abstract describing the dataset | Brief narrative summary of the content of the resource(s)<br><br>MD_Metadata > MD_DataIdentification.abstract | Mandatory | 1 | Character String | Free Text |
| 4 | **metadata point of contact**<br><br>ISO: metadata point of contact | Party responsible for the metadata information<br><br>MD_Metadata.contact > CI_ResponsibleParty | Mandatory | N | Compound | Table B.1.2<br>Use at least 2&4 (organization name and role) |
| 5 | **metadata date stamp**<br><br>ISO: metadata date stamp | Date that the metadata was created<br><br>MD_Metadata.dateStamp | Mandatory | 1 | Date | Date<br>(ISO 8601) |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 6 | **dataset language**<br><br>ISO: dataset language | Language(s) used within the dataset<br><br>MD_Metadata > MD_DataIdentification.language | Mandatory | N | Character String | ISO 639-3 |
| 7 | **security**<br><br>ISO: classification | Security classification and security handling instructions carried by the resource<br><br>MD_Metadata > MD_Constraints > MD_SecurityConstraints.classification | Mandatory | N | Compound | Table B.1.3 (use IC ISM for classified) |
| 8 | **identifier**<br><br>ISO: dataset identifier | Unambiguous reference to the resource within a given context<br>MD_Metadata > MD_DataIdentification.citation > CI_Citation.identifier > MD_Identifier.code | Mandatory[2] | N | Character String | Free Text |
| 9 | **resource originator**<br><br>ISO: dataset responsible party | entity primarily responsible for making the content of the resource<br><br>MD_Metadata > MD_DataIdentification.pointOfContact > CI_ResponsibleParty | Mandatory[2] | N | Compound | Table B.1.2 Use at least 2&4 (organization name and role) |
| 10 | **keyword**<br><br>ISO: keyword | Topic of the content of the resource<br><br>MD_Metadata > MD_Keywords.keyword | Mandatory[2] | N | Character String | Free Text |
| 11 | **hierarchy level**<br><br>ISO: metadata hierarchy level | Scope to which the metadata applies<br><br>MD_Metadata.hierarchyLevel | Conditional / Mandatory if value does not = 'dataset' | N | Codelist | Table B.2.2 |
| 12 | **hierarchy level name**<br><br>ISO: metadata hierarchy level name | Name of the hierarchy level for which the metadata is provided<br><br>MD_Metadata.hierarchyLevelName | Conditional / Mandatory if hierarchy level does not = 'dataset' | N | Character String | Free Text |
| 13 | **dataset topic category**<br><br>ISO: dataset topic category | Main theme(s) of the dataset<br><br>MD_Metadata > MD_DataIdentification.topicCategory | Conditional / Mandatory if hierarchy level = 'dataset' | N | Codelist | Table B.2.3 |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 14 | **geographic bounding box**<br><br>ISO: geographic location of the dataset (by four coordinates) | Geographic position of the dataset; this is only an approximate reference, specifying the coordinate reference system is unnecessary<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_GeographicBoundingBox | Conditional (required if hierarchy level = dataset and geographic identifier not documented) | 1 | Compound | Row 14.1-14.4 |
| 14.1 | **westbound longitude**<br><br>ISO: westbound longitude | Western-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degree (positive east) | Mandatory | 1 | Real | -180.0<= West Bounding Longitude Value <= 180.0 |
| 14.2 | **eastbound longitude**<br><br>ISO: eastbound longitude | Eastern-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east) | Mandatory | 1 | Real | -180.0<= East Bounding Longitude Value <= 180.0 |
| 14.3 | **southbound latitude**<br><br>ISO: southbound latitude | Southern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north) | Mandatory | 1 | Real | -90.0 <= South Bounding Latitude Value <= 90.0 |
| 14.4 | **northbound latitude**<br><br>ISO: northbound latitude | Northern-most coordinate of the limit of the dataset extent expressed in latitude in decimal degrees (positive north) | Mandatory | 1 | Real | -90.0 <= North Bounding Latitude Value <= 90.0 |
| 15 | **geographic identifier**<br><br>ISO: geographic location of the dataset (by geographic identifier) | Identifier used to represent a geographic area<br><br>MD_Metadata > MD_DataIdentification > EX_Extent > EX_GeographcExtent > EX_GeographicDescription.geographicIdentifier | Conditional / Mandatory if 'geographic bounding box' not documented | N | Character String | Free Text: Generally populated with country code. (FIPS-10-4, Also may be ISO 3166-1 if/when U.S. codes are cross-referenced for reserved codes missing or different from FIPS-10-4) |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 16 | **temporal extent**<br><br>ISO: additional extent information (temporal) | Information about the temporal extent of the dataset<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_TemporalExtent | Conditional / Mandatory when applicable | N | Class | TM_Primitive (ISO 19108) |
| 17 | **resource character set**<br><br>ISO: dataset character set | Full name of the character coding standard used for the dataset<br><br>MD_Metadata > MD_DataIdentification.characterSet | Conditional / Mandatory when ISO 10646-1 not used | N | Codelist | Table B.2.4 |
| 18 | **metadata language**<br><br>ISO: metadata language | Language used for documenting metadata<br><br>MD_Metadata.language | Conditional / Mandatory when not defined by the encoding | N | Character String | ISO 639-3 |
| 19 | **online resource**<br><br>ISO: online resource linkage | Information about on-line sources from which the dataset can be obtained<br><br>MD_Metadata > MD_Distribution > MD_DigitalTransferOptions.onLine > CI_OnLineResource.linkage | Conditional / Mandatory if 'geographic bounding box' and 'temporal extent' not documented | N | URL | URL |
| 20 | **metadata standard name**<br><br>ISO: metadata standard name | Name of the metadata standard (including profile name) used<br><br>MD_Metadata.metadataStandardName | Optional | 1 | Character String | NSG Geosapatial Core Metadata Profile |
| 21 | **metadata standard version**<br><br>ISO: metadata standard version | Version (profile) of the metadata standard used<br><br>MD_Metadata.metadataStandardVersion | Optional | 1 | Character String | 1.0 |
| 22 | **metadata character set**<br><br>ISO: metadata character set | Full name of the character coding standard used for the metadata set<br><br>MD_Metadata.characterSet | Optional | 1 | Codelist | Table B.2.4 |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 23 | **spatial representation type**<br><br>ISO: spatial representation type | Method used to spatially represent geographic information<br><br>MD_Metadata > MD_DataIdentification.spatialRepresentationType | Optional | N | Codelist | "Grid" |
| 24 | **distribution format**<br><br>ISO: distribution format | Despcription of the computer language construct that specifies the representation of data objects in a record, file, message, storage device or transmission channel<br><br>MD_Metadata > MD_Distribution > MD_Format | Mandatory[2] | N | Compound | Row 24.1-24.5 |
| 24.1 | **distribution format name**<br><br>ISO: name | Name of the data transfer format(s)<br><br>MD_Metadata > MD_Distribution > MD_Format.name | Mandatory[2] | 1 | Character String | GeoTIFF Rev 1.0 |
| 24.2 | **distribution format version**<br><br>ISO: version | Version of the format (date, number, etc.)<br><br>MD_Metadata > MD_Distribution > MD_Format.version | Mandatory[2] | 1 | Character String | 1.8.2 |
| 24.3 | **distribution format specification**<br><br>ISO: specification | Name of a subset, profile, or product specification of the format<br><br>MD_Metadata > MD_Distribution > MD_Format.specification | Conditional | 1 | Character String | detailed product specification, if any, used to define this GeoTIFF file |
| 24.4 | **transfer size**<br><br>ISO: transfer size | Estimated size of a unit in the specified transfer format, expressed in megabytes.<br><br>MD_Metadata > MD_Distribution > MD_DigitialTransferOptions.transferSize | Mandatory | 1 | Real | > 0.0 |
| 25 | **resource point of contact**<br><br>ISO: dataset responsible party | Identification of, and means of communication with, person(s) and organization(s) associated with the resource<br><br>MD_Metadata > MD_DataIdentification.pointOfContact > CI_ResponsibleParty | Optional | N | Compound | Table B.1.2<br>Use at least 2&4 (organization name and role) |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 26 | **lineage**<br><br>ISO: lineage | Information about the events or source data used in constructing the data specified by the scope or lack of knowledge about lineage<br><br>MD_Metadata > DQ_DataQuality.lineage > LI_Lineage | Optional | 1 | Character String | Free Text |
| 27 | **reference system**<br><br>ISO: reference system | Description of the spatial and temporal reference systems used in the dataset<br><br>MD_Metadata > MD_ReferenceSystem.referenceSystemIdentifier | Optional | 1 | Character String | Free text |
| 28 | **resource spatial resolution**<br><br>ISO: spatial resolution | Factor which provides a general understanding of the density of spatial data in the dataset<br><br>MD_Metadata > MD_DataIdentification.spatialResolution > MD_Resolution | Mandatory | 1 | Compound | Row 28.1-28.2 |
| 28.1 | **equivalent scale**<br><br>ISO: equivalent scale denominator | Level of detail expressed as the scale of a comparable hardcopy map or chart<br><br>MD_Metadata > MD_DataIdentification.spatialResolution > MD_Resolution.equivalentScale > MD_RepresentativeFraction.denominator | Conditional / distance documented? | 1 | Integer | Integer > 0 |
| 28.2 | **distance**<br><br>ISO: distance | Ground sample distance<br><br>MD_Metadata > MD_DataIdentification.spatialResolution > MD_Resolution.distance | Conditional / eq. scale documented? | 1 | Class | Distance (ISO/TS 19103) |
| 29 | **metadata file identifier**<br><br>ISO: metadata file identifier | Unique identifier for this metadata file<br><br>MD_Metadata.fileIdentifier | Optional | N | Character String | Free Text |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 30 | **vertical extent**<br><br>ISO: additional extent information for the dataset (vertical) | Extent information including the vertical extent of the dataset<br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_VerticalExtent | Optional | N | Compound | Row 30.1-30.4 |
| 30.1 | **minimum vertical extent**<br><br>ISO: minimum value | Lowest vertical extent contained in the dataset<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_VerticalExtent.minimumValue | Mandatory | 1 | Real | Real |
| 30.2 | **maximum vertical extent**<br><br>ISO: maximum value | Highest vertical extent contained in the dataset<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_VerticalExtent.maximumValue | Mandatory | 1 | Real | Real |
| 30.3 | **vertical reference system**<br><br>ISO: vertical datum | Provides information about the origin from which the maximum and minimum elevation values are measured<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_VerticalExtent > SC_VerticalDatum | Mandatory | 1 | Character String | ISO 19111 |
| 30.4 | **unit of measure**[1]<br><br>ISO: unit of measure | Vertical units used for vertical extent information.<br><br>MD_Metadata > MD_DataIdentification.extent > EX_Extent > EX_VerticalExtent.unitOfMeasure | Mandatory | 1 | Class | ISO/TS 19103 (use meters) |
| 31 | **rights**<br><br>ISO: dataset legal contraints | Constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations or warnings on using a shared resource.<br><br>MD_Metadata > MD_Contraints > MD_LegalConstraints.accessConstraits/useConstraints | Mandatory | N | Codelist | Table B.2.5 (for profile: use 'other restrictions' code when no legal constraints exist) |
| 32 | **other constraints**<br>ISO: other constraints | Other restrictions and legal prerequisites for accessing and using the resource<br><br>MD_Metadata > MD_Contraints > MD_LegalConstraints.otherConstraints | Conditional (Rights code = 'other restrictions') | N | CharacterString | Free Text (for profile: when no legal constraints exist, declare this here) |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 32 | **relation**<br><br>ISO: N/A | Reference to a related resource<br><br>*Note: numerous varieties of relationships are described in ISO 19115 which address the detailed relationships of such things as hierarchies and aggregations. A single element relationship as depicted in the NGCMP is insufficient to satisfy the needs of relationships for geospatial imagery data.* | Mandatory | N | Character String | Free Text |
| 33 | **use**<br><br>ISO: dataset usage | Brief description of the useage<br><br>MD_Metadata > MD_DataIdentification > MD_Usage.specificUsage | Optional | N | Character String | Free Text |
| 34 | **quality**<br><br>ISO: dataset quality | Information about the data quality measures applied to the resource<br><br>MD_Metadata > DQ_DataQuality | Optional | N | Compound | Table B.1.4 |
| 35 | **geospatial extensions**<br><br>ISO: N/A | Additional extensions to supplemental metadata<br><br>*Note: Construct of this element is unique to NGCMP and not addressed in ISO 19115.* | Mandatory | N | Codelist | "001" (Raster/Imagery) (C3.T1.2 from NGCMP) |
| *Elements below (36-39) are examples of metadata elements that are specific to raster datasets (from raster core in NGCMP)* | | | | | | |
| 36 | **image GEO**<br><br>ISO: polygon | Geo-location of the image<br>Note: this is only an approximate reference so specifying the coordinate system is unnecessary<br><br>MD_Metadata > MD_DataIdentification > EX_Extent > EX_GeographicExtent > EX_BoundingPolygon | Mandatory | 1 | Class | GM_Object (ISO 19107)<br>-90 to 90 latitude<br>-180 to 360 longitude |
| 37 | **image acquisition date**<br><br>ISO: temporal extent | Date the target was acquired<br><br>MD_Metadata > MD_DataIdentification > EX_Extent > EX_TemporalExtent.extent | Mandatory | 1 | Date | ISO 8601 |

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 38 | **radiometric resolution**[1]<br>ISO: coverage bits per range value | Bits per sample<br><br>MD_ContentInformation > MD_CoverageDescription > MD_RangeDimension > MD_Band.bitsPerValue | Optional | 1 | Integer | 8, 16 or 32 |
| 39 | **image/grid dimensions**[1]<br><br>ISO: grid dimension name and size | Number of rows and columns of range values in the dataset.<br><br>MD_Metadata.spatialRepresentationInfo.MD_GridSpatialRepresentation.axisDimensionProperties.MD_Dimension.dimension(Name and Size) | Mandatory | 1 | Character String | Free Text |

[1] - Element not addressed in NGCMP version 1.
[2] - Obligation/Condition more restrictive than in NGCMP version 1.

**Table B.1.2: Contact Metadata**
(ISO 19115: CI_ResponsibleParty and CI_Citation)

| Row # | Name | Description | Obligation/ Condition | Max Occur | Data Type | Domain |
|---|---|---|---|---|---|---|
| 1 | **individual name**<br><br>ISO: individual Name | Name of the responsible person – surname, given name, title – separated by a delimeter<br><br>MD_Metadata.contact > CI_ResponsibleParty.individualName | Conditional | 1 | Character String | Free Text |
| 2 | **organization name**<br><br>ISO: organisation name | Name of the responsible organization<br><br>MD_Metadata.contact > CI_ResponsibleParty.organisationName | Mandatory | 1 | Character String | Free Text |
| 3 | **position name**<br><br>ISO: position name | Role or position of the responsible person<br><br>MD_Metadata.contact > CI_ResponsibleParty.postitionName | Conditional | 1 | Character String | Free Text |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | **role**<br><br>ISO: Role | Function performed by the responsible party<br><br>MD_Metadata.contact > CI_ResponsibleParty.role | Mandatory | 1 | Class | Table B.2.6 |
| 5 | **hours of service**<br><br>ISO: hours of service | Time period (including time zone) when individuals can contact the organization or individual<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.hoursOfService | Optional | 1 | Character String | Free Text |
| 6 | **contact instructions**<br><br>ISO: contact instructions | Supplemental instructions on how or when to contact the individual or organization<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.contactInstructions | Optional | 1 | Character String | Free Text |
| 7 | **linkage**<br><br>ISO: linkage | Location (address) for on-line access using a Uniform Resource Locator address or similar addressing scheme<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.linkage | Optional | 1 | Class | URL |
| 8 | **protocol**<br><br>ISO: protocol | Connection protocol to be used<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.protocol | Optional | 1 | Character String | Free Text |
| 9 | **application profile**<br><br>ISO: application profile | Name of an application profile that can be used with the online resource<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.applicationProfile | Optional | 1 | Character String | Free Text |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | **online resource name**<br><br>ISO: online resource name | Name of the online resource<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.name | Optional | 1 | Character String | Free Text |
| 11 | **online resource description**<br><br>ISO: online resource description | Detailed text description of what the online resource is/does<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.description | Optional | 1 | Character String | Free Text |
| 12 | **online resource function**<br><br>ISO: online resource function | Code for function performed by the online resource<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.onlineResource > CI_OnlineResource.function | | | | |
| 13 | **delivery point**<br><br>ISO: delivery point | Address line for the location (as described in ISO 11180, annex A)<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.deliveryPoint | Optional | N | Character String | Free Text |
| 14 | **city**<br><br>ISO: city | City of the location<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.city | Optional | 1 | Character String | Free Text |
| 15 | **administrative area**<br><br>ISO: administrative area | State, province of the location<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.administrativeArea | Optional | 1 | Character String | Free Text |

| | | | | | | |
|---|---|---|---|---|---|---|
| 16 | **postal code**<br><br>ISO: postal code | ZIP or other postal code<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.postalCode | Optional | 1 | Character String | Free Text |
| 17 | **country**<br><br>ISO: country | Country of the physical address<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.country | Optional | 1 | Character String | ISO 3166-1, other parts may be used |
| 18 | **electronic mail address**<br><br>ISO: electronic mail address | Address of the electronic mailbox of the responsible organization or individual<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.address > CI_Address.electronicMailAddress | Optional | N | Character String | Free Text |
| 19 | **telephone number**<br><br>ISO: phone | Telephone number by which individuals can speak to the responsible organization or individual<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.phone > CI_Telephone.voice | Optional | N | Character String | Free Text |
| 20 | **facsimile number**<br><br>ISO: facsimile | Telephone number of a facsimile machine for the responsible organization or individual<br><br>MD_Metadata.contact > CI_ResponsibleParty.contactInfo > CI_Contact.phone > CI_Telephone.facsimile | Optional | N | Character String | Free Text |

**Table B.1.3: Metadata Security Elements (from IC ISM)**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Classification | Highest level of classification applicable to an information resource or portion within the domain of classified national security information | Mandatory | 1 | Code | See IC ISM |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Owner/Producer | The national government or international organization owner(s) and/or producer(s) of a resource | Mandatory | 1 | Code | ISO 3166-1 CAPCO-defined International Organization Tetragraphic Codes |
| 3 | Classification Reason | The basis for an original classification decision | Optional | 1 | Character String | Free Text |
| 4 | Classified By | The identity, by name or personal identifier, and position title of the original classification authority for a resource | Optional | 1 | Character String | Free Text |
| 5 | Date of Exempted Source | The year, month and day of publication or release of a source document, or the most recent source document, that was itself marked with a declassification constraint | Optional | 1 | Date | YYYY-MM-DD<br><br>See IC ISM. |
| 6 | Declassification Date | A specific year, month and day for declassification, based on the duration of the national security sensitivity of the information, upon the occurrence of which the information shall be automatically declassified | Optional | 1 | Date | YYYY-MM-DD |
| 7 | Declassification Event | A description of an event for declassification, based upon the duration of the national security sensitivity of the information, upon the occurrence of which the information shall be automatically declassified | Optional | 1 | Character String | Free Text |
| 8 | Declassification Exception | One or more exceptions to the nominal 25-year point for automatic declassification | Optional | 1 | Code | See IC ISM. |
| 9 | Declassification Manual Review Indicator | An indication of a requirement for manual review prior to declassification, over and above the usual programmatic determinations | Optional | 1 | Boolean | “true” or “1”, “false” or “0” |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Derived From | A citation of the authoritative source or reference to multiple sources of the classification markings used in a resource | Optional | 1 | Character String | Free Text |
| 11 | Dissemination Controls | Controls which identify the expansion or limitation on the distribution of information | Optional | 1 | Code | See IC ISM |
| 12 | FGI Open Source | An indication that information qualifies as foreign government information according to CAPCO guidelines for which the source(s) of the information is not concealed | Optional | 1 | Code | ISO 3166-1 Country Trigraphic Codes<br><br>CAPCO-defined International Organization Tetragraphic Codes |
| 13 | FGI Protected Source | An indication that information qualifies as foreign government information according to CAPCO guidelines for which the source(s) of the information must be concealed when the information is disseminated in ICSIS shared spaces | Optional | 1 | Code | ISO 3166-1 Country Trigraphic Codes<br><br>CAPCO-defined International Organization Tetragraphic Codes |
| 14 | Non-Intelligence Community Markings | Information security classification markings for classified information originating from non-intelligence components | Optional | 1 | Code | See IC ISM. |
| 15 | Releasability | The country or countries and/or international organization(s) to which classified information may be released based on the determination of an originator in accordance with established foreign disclosure procedures | Conditional / Required if “Dissemination Controls” = “REL” or “EYES” | 1 | Code | ISO 3166-1 Country Trigraphic Codes<br><br>CAPCO-defined International Organization Tetragraphic Codes |
| 16 | Special Access Program Identifier | Registered trigraphic or digraphic code(s) for defense or intelligence programs for which special access is required | Optional | 1 | Code | See IC ISM. |
| 17 | SCI Controls | CAPCO-authorized abbreviations for sensitive compartmented information control system(s) | Optional | 1 | Code | See IC ISM. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 18 | Type of Exempted Source | A declassification marking of a source document that causes the current, derivative document to be exempted from automatic declassification | Optional | 1 | Code | See IC ISM. |

**Table B.1.4: Metadata Data Quality Elements**
(ISO 19115: DQ_DataQuality)

| Row # | Name | Definition | Obligation / Condition | Maximum occurrence | Data type | Domain |
|---|---|---|---|---|---|---|
| 1 | **scope level**<br><br>ISO: scope level | extent of characteristic(s) of the data for which quality information is reported. example: All items classified as houses<br><br>MD_Metadata > DQ_DataQuality.scope > DQ_Scope.level | Mandatory | 1 | Codelist | Table B.2.2 |
| 2 | **scope description**<br><br>ISO: scope level description | detailed description about the level of the data specified by the scope<br><br>The data quality scope can apply to attributes, feature types, attribute instances, feature type instances or datasets. This element defines the specifics of what the scope applies to.<br><br>MD_Metadata > DQ_DataQuality.scope > DQ_Scope.levelDescription | Conditional / Required if “scope level” not equal to “dataset” or “series” | N | Character String | Free text |
| 3 | **name of measure**<br><br>ISO: name of measure | name of the test applied to the Data<br><br>MD_Metadata > DQ_DataQuality.nameOfMeasure | Optional | N | Character String | Free text |

| Row # | Name | Definition | Obligation / Condition | Maximum occurrence | Data type | Domain |
|---|---|---|---|---|---|---|
| 4 | **measure identification**<br><br>ISO: measure identification | code identifying a registered standard procedure<br><br>MD_Metadata > DQ_DataQuality.measureIdentification > MD_Identifier.code | Optional | 1 | Character String | Free text |
| 5 | **measure description**<br><br>ISO: measure description | description of the measure. example: Percentage of commissions<br><br>MD_Metadata > DQ_DataQuality.measureDescription | Optional | 1 | Character String | Free text |
| 6 | **evaluation method type**<br><br>ISO: evaluation method type | type of method used to evaluate quality of the dataset. example: 2 – External<br><br>MD_Metadata > DQ_DataQuality.evaluationMethodType > DQ_EvaluationMethodTypeCode | Optional | 1 | Codelist | Table B.2.7 |
| 7 | **evaluation method description**<br><br>ISO: evaluation method description | description of the evaluation Method. example: Divide count of excess items in dataset by count of items in universe of discourse; then multiply by 100.<br><br>MD_Metadata > DQ_DataQuality.evaluationMethodDescription | Optional | 1 | Character String | Free text |
| 8 | **evaluation procedure**<br><br>ISO: evaluation procedure | reference to the procedure Information<br><br>MD_Metadata > DQ_DataQuality.evaluationProcedure > CI_Citation | Optional | 1 | Class | Table B.1.2 |

| Row # | Name | Definition | Obligation / Condition | Maximum occurrence | Data type | Domain |
|---|---|---|---|---|---|---|
| 9 | **date**<br><br>ISO: date time | date or range of dates on which a data quality measure was applied<br><br>MD_Metadata > DQ_DataQuality.dateTime | Optional | N | Date | ISO 8601 |
| 10 | **quantitative result**<br><br>ISO: result value type | the values or information about the value(s) (or set of values) obtained from applying a data quality Measure<br><br>MD_Metadata > DQ_DataQuality.result > DQ_QuantitativeResult.valueType | Conditional / either Qualitative or Conformance result must be documented | N | Class | RecordType (ISO 19103) |
| 11 | **quantitative result unit**<br><br>ISO: result value unit | value unit for reporting a data quality result<br><br>MD_Metadata > DQ_DataQuality.result > DQ_QuantitativeResult.valueUnit | Conditional / documented if Quantitative result is documented | 1 | Class | UnitOfMeasure (ISO 19103) |
| 12 | **conformance result**<br><br>ISO: conformance result | Indication of the conformance result where 1 = pass, 0 = fail.<br><br>MD_Metadata > DQ_DataQuality.result > DQ_ConformanceResult.pass | Conditional / either Quantitative or Conformance result must be documented | 1 | Boolean | 1 = yes<br>0 = no |
| 13 | **conformance result specification**<br><br>ISO: conformance result specification | citation of product specification or user requirement against which data is being evaluated<br><br>MD_Metadata > DQ_DataQuality.result > DQ_ConformanceResult.specification | Optional | 1 | Class | Table B.1.2 |

## B.2 Metadata Code Tables

The following tables are included for the convenience of the readers/users of this profile document to provide context in understanding the application of supplemental metadata illustrated by the example provided in this appendix. Implementers of this profile shall make use of the metadata element and codelists specified in the source standards, NSG adopted metadata profiles and NSG-authorized registers that are current at the time of implementation. Note that NSG adopted metadata profiles may impose constraints on codes and values listed below for use within the NSG.

**Table B.2.1: CI_DateTypeCode**

| Name | Domain Code | Definition |
|---|---|---|
| CI_DateTypeCode | DateTypCd | identification of when a given event occurred |
| creation | 001 | date identifies when the resource was brought into existence |
| publication | 002 | date identifies when the resource was issued |
| revision | 003 | date identifies when the resource was examined or re-examined and improved or amended |

**Table B.2.2: MD_ScopeCode**

| Name | Domain Code | Definition |
|---|---|---|
| MD_ScopeCode | ScopeCd | Class of information to which the referencing entity applies |
| attribute | 001 | information applies to the attribute class |
| attributeType | 002 | information applies to the characteristic of a feature |
| collectionHardware | 003 | information applies to the collection hardware class |
| collectionSession | 004 | information applies to the collection session |
| dataset | 005 | information applies to the dataset |
| series | 006 | information applies to the series |
| nonGeographicDataset | 007 | information applies to non-geographic data |
| dimensionGroup | 008 | information applies to a dimension group |
| feature | 009 | information applies to a feature |
| featureType | 010 | information applies to a feature type |
| propertyType | 011 | information applies to a property type |
| fieldSession | 012 | information applies to a field session |
| software | 013 | information applies to a computer program or routine |
| service | 014 | information applies to a capability which a service provider entity makes available to a service user entity through a set of interfaces that define a behaviour, such as a use case |
| model | 015 | information applies to a copy or imitation of an existing or hypothetical object |
| tile | 016 | information applies to a tile, a spatial subset of geographic data |

**Table B.2.3: MD_TopicCategoryCode**

| Name | Domain Code | Definition |
|---|---|---|
| MD_TopicCategoryCode | TopicCatCd | Description (list not exhaustive and overlaps do exist; use most appropriate) |
| farming | 001 | rearing of animals and/or cultivation of plants<br><br>Examples: agriculture, irrigation, aquaculture, plantations, herding, pests and diseases affecting crops and livestock |
| biota | 002 | flora and/or fauna in natural environment<br><br>Examples: wildlife, vegetation, biological sciences, ecology, wilderness, sealife, wetlands, habitat |
| boundaries | 003 | legal land descriptions<br><br>Examples: political and administrative boundaries |
| climatologyMeteorologyAtmosphere | 004 | processes and phenomena of the atmosphere<br><br>Examples: cloud cover, weather, climate, atmospheric conditions, climate change, precipitation |
| economy | 005 | economic activities, conditions and employment<br><br>Examples: production, labour, revenue, commerce, industry, tourism and ecotourism, forestry, fisheries, commercial or subsistence hunting, exploration and exploitation of resources such as minerals, oil and gas |
| elevation | 006 | height above or below sea level<br><br>Examples: altitude, bathymetry, digital elevation models, slope, derived products |
| environment | 007 | environmental resources, protection and conservation<br><br>Examples: environmental pollution, waste storage and treatment, environmental impact assessment, monitoring environmental risk, nature reserves, landscape |
| geoscientificInformation | 008 | information pertaining to earth sciences<br><br>Examples: geophysical features and processes, geology, minerals, sciences dealing with the composition, structure and origin of the earth's rocks, risks of earthquakes, volcanic activity, landslides, gravity information, soils, permafrost, hydrogeology, erosion |

| | | |
|---|---|---|
| health | 009 | health, health services, human ecology, and safety<br><br>Examples: disease and illness, factors affecting health, hygiene, substance abuse, mental and physical health, health services |
| imageryBaseMapsEarthCover | 010 | base maps<br><br>Examples: land cover, topographic maps, imagery, unclassified images, annotations |
| intelligenceMilitary | 011 | military bases, structures, activities<br><br>Examples: barracks, training grounds, military transportation, information collection |
| inlandWaters | 012 | inland water features, drainage systems and their characteristics<br><br>Examples: rivers and glaciers, salt lakes, water utilization plans, dams, currents, floods, water quality, hydrographic charts |
| location | 013 | positional information and services<br><br>Examples: addresses, geodetic networks, control points, postal zones and services, place names |
| oceans | 014 | features and characteristics of salt water bodies<br>(excluding inland waters)<br><br>Examples: tides, tidal waves, coastal information, reefs |
| planningCadastre | 015 | information used for appropriate actions for future use of the land<br><br>Examples: land use maps, zoning maps, cadastral surveys, land ownership |
| society | 016 | characteristics of society and cultures<br><br>Examples: settlements, anthropology, archaeology, education, traditional beliefs, manners and customs, demographic data, recreational areas and activities, social impact assessments, crime and justice, census information |
| structure | 017 | man-made construction<br><br>Examples: buildings, museums, churches, factories, housing, monuments, shops, towers |
| transportation | 018 | means and aids for conveying persons and/or goods<br><br>Examples: roads, airports/airstrips, shipping routes, tunnels, nautical charts, vehicle or vessel location, aeronautical charts, railways |

| | | |
|---|---|---|
| utilitiesCommunication | 019 | energy, water and waste systems and communications infrastructure and services<br><br>Examples: hydroelectricity, geothermal, solar and nuclear sources of energy, water purification and distribution, sewage collection and disposal, electricity and gas distribution, data communication, telecommunication, radio, communication networks |

**Table B.2.4: MD_CharacterSetCode**

| Name | Domain Code | Definition |
|---|---|---|
| MD_CharacterSetCode | CharSetCd | Name of the character coding standard used for the resource |
| ucs2 | 001 | 16-bit fixed size Universal Character Set, based on ISO/IEC 10646 |
| ucs4 | 002 | 32-bit fixed size Universal Character Set, based on ISO/IEC 10646 |
| utf7 | 003 | 7-bit variable size UCS Transfer Format, based on ISO/IEC 10646 |
| utf8 | 004 | 8-bit variable size UCS Transfer Format, based on ISO/IEC 10646 |
| utf16 | 005 | 16-bit variable size UCS Transfer Format, based on ISO/IEC 10646 |
| 8859part1 | 006 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No. 1 |
| 8859part2 | 007 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 2: Latin alphabet No. 2 |
| 8859part3 | 008 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 3: Latin alphabet No. 3 |
| 8859part4 | 009 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 4: Latin alphabet No. 4 |
| 8859part5 | 010 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 5: Latin/Cyrillic alphabet |
| 8859part6 | 011 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 6: Latin/Arabic alphabet |
| 8859part7 | 012 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 7: Latin/Greek alphabet |
| 8859part8 | 013 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 8: Latin/Hebrew alphabet |
| 8859part9 | 014 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 9: Latin alphabet No. 5 |
| 8859part10 | 015 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 10: Latin alphabet No. 6 |
| 8859part11 | 016 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 11: Latin/Thai alphabet |
| (reserved for future use) | 017 | a future ISO/IEC 8-bit single-byte coded graphic character set (e.g. possibly 8859part12) |
| 8859part13 | 018 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 13: Latin alphabet No. 7 |
| 8859part14 | 019 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 14: Latin alphabet No. 8 (Celtic) |
| 8859part15 | 020 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 15: Latin alphabet No. 9 |
| 8859part16 | 021 | ISO/IEC 8-bit single-byte coded graphic character sets – Part 16: Latin alphabet No. 10 |
| jis | 022 | japanese code set used for electronic transmission |
| shiftJIS | 023 | japanese code set used on MS-DOS based machines |
| eucJP | 024 | japanese code set used on UNIX based machines |
| usAscii | 025 | united states ASCII code set (ISO 646 US) |
| ebcdic | 026 | ibm mainframe code set |
| eucKR | 027 | korean code set |

| | | |
|---|---|---|
| big5 | 028 | traditional Chinese code set used in Taiwan, Hong Kong of China and other areas |
| GB2312 | 029 | simplified Chinese code set |

**Table B.2.5: MD_RestrictionCode**

| Name | Domain Code | Definition |
|---|---|---|
| MD_RestrictionCode | RestrictCd | limitation(s) placed upon the access or use of the data |
| copyright | 001 | exclusive right to the publication, production, or sale of the rights to a literary, dramatic, musical, or artistic work, or to the use of a commercial print or label, granted by law for a specified period of time to an author, composer, artist, distributor |
| patent | 002 | government has granted exclusive right to make, sell, use or license an invention or discovery |
| patentPending | 003 | produced or sold information awaiting a patent |
| trademark | 004 | a name, symbol, or other device identifying a product, officially registered and legally restricted to the use of the owner or manufacturer |
| license | 005 | formal permission to do something |
| intellectualPropertyRights | 006 | rights to financial benefit from and control of distribution of non-tangible property that is a result of creativity |
| restricted | 007 | withheld from general circulation or disclosure |
| otherRestrictions | 008 | limitation not listed |

**Table B.2.6: CI_RoleCode**

| Name | Domain Code | Definition |
|---|---|---|
| CI_RoleCode | RoleCd | function performed by the responsible party |
| resourceProvider | 001 | party that supplies the resource |
| custodian | 002 | party that accepts accountability and responsibility for the data and ensures appropriate care and maintenance of the resource |
| owner | 003 | party that owns the resource |
| user | 004 | party who uses the resource |
| distributor | 005 | party who distributes the resource |
| originator | 006 | party who created the resource |
| pointOfContact | 007 | party who can be contacted for acquiring knowledge about or acquisition of the resource |

| | | |
|---|---|---|
| principalInvestigator | 008 | key party responsible for gathering information and conducting research |
| processor | 009 | party who has processed the data in a manner such that the resource has been modified |
| publisher | 010 | party who published the resource |
| author | 011 | party who authored the resource |

**Table B.2.7: DQ_EvaluationMethodTypeCode**

| Name | Domain Code | Definition |
|---|---|---|
| DQ_EvaluationMethodTypeCode | EvalMethTypeCd | type of method for evaluating an identified data quality measure |
| directInternal | 001 | method of evaluating the quality of a dataset based on inspection of items within the dataset, where all data required is internal to the dataset being evaluated |
| directExternal | 002 | method of evaluating the quality of a dataset based on inspection of items within the dataset, where reference data external to the dataset being evaluated is required |
| indirect | 003 | method of evaluating the quality of a dataset based on external knowledge |

# Appendix C – Supplemental Metadata Schema Information

The example conceptual metadata requirements in Appendix B were selected from the conceptual data model in ISO 19115. ISO/TS 19139:2007 Geographic Information – Metadata – XML Schema Implementation defines Geographic MetaData XML (gmd) encoding, an XML Schema implementation derived from ISO 19115. 19139 defines the content of six XML Namespaces commonly identified using the following prefixes: gco, gmd, gmx, gsr, gss, and gts. Each of these namespace prefixes is appended to http://www.isotc211.org/2005/ to make a complete namespace identifier. The XML Schemas associated with each of these namespaces can be found at http://www.iso.org/ittf/ISO_19139_Schemas with the following directory and file structure;

- The files that make up the Geographic COmmon extensible markup language or http://www.isotc211.org/2005/gco are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gco” directory and are: basicTypes.xsd, gco.xsd and gcoBase.xsd.

- The files that make up the Geographic MetaData extensible markup language or http://www.isotc211.org/2005/gmd are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gmd” directory and are: applicationSchema.xsd, avantfreeText.xsd, citation.xsd, constraints.xsd, content.xsd, dataQuality.xsd, distribution.xsd, extent.xsd, freeText.xsd, gmd.xsd, identification.xsd, maintenance.xsd, metadataApplication.xsd, metadataEntity.xsd, metadataExtension.xsd, portrayalCatalogue.xsd, referenceSystem.xsd, and spatialRepresentation.xsd.

- The files that make up the Geographic Metadata XML Schema or http://www.isotc211.org/2005/gmx are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gmx” directory and are: catalogues.xsd, codelistItem.xsd, crsItem.xsd, extendedTypes.xsd, gmx.xsd, gmxUsage.xsd, and uomItem.xsd.

- The files that make up the Geographic Spatial Referencing extensible markup language or http://www.isotc211.org/2005/gsr are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gsr” directory and are: gsr.xsd and spatialReferencing.xsd.

- The files that make up the Geographic Spatial Schema extensible markup language or http://www.isotc211.org/2005/gss are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gss” directory and are: geometry.xsd and gss.xsd.

- The files that make up the Geographic Temporal Schema extensible markup language or http://www.isotc211.org/2005/gts are found at http://www.iso.org/ittf/ISO_19139_Schemas in the “gts” directory and are: gts.xsd and temporalObjects.xsd.

- The ISO/TS 19139 XML schema implementation of ISO 19115 also provides the option of encoding information in-line in a metadata instance element or providing a reference to an instance of a metadata element containing the information that is located elsewhere. This technique uses Xlinks (specifically the *xlink:href* attribute) to identify a local or remote instantiation of a metadata element. By using linking, a metadata instance can be more compact with fewer instances of identical information being repeated throughout the document. The xml linking language namespace is found at http://www.w3.org/1999/xlink. The schema document is available at http://www.isotc211.org/2005/xlink and http://schemas.opengis.net/gml/3.1.1/xlink/.

- In addition to the ISO namespaces listed above, files that make up the Open Geospatial Consortuim's Geography Markup Language or http://www.opengis.net/gml are also permitted and are included in the example XML instance document in Appendix D. The OGC site also mirrors the TC211 ISO 19139 .xsd documents at http://schemas.opengis.net/iso/19139/20070417.

To ease the use of ISO 19139, several xml files are available for download in the "resources" directory at http://www.isotc211.org/2005/resources. They are organized into the following categories of support: Codelists, Coordinate Reference Systems and Units of Measure. The xml files related to the utilization of codelists that are available for download are found in the "Codelist" directory of the "resources". Those files are ML_gmxCodelists.xml (multi-lingual codelists) and gmxCodelists.xml (standard codelists based on ISO 19115). The xml files related to the utilization of coordinate reference systems that are available for download are found in the "crs" directory of the "resources". Those files are ML_gmxCrs.xml (multi-lingual CRSs) and gmxCrs.xml (standard CRSs). The xml files related to the utilization of units of measure that are available for download are found in the "uom" directory of the "resources". Those files are ML_gmxUom.xml (multi-lingual UnitsOfMeasures) and gmxUom.xml (standard UnitsOfMeasures).

# Appendix D – Metadata Example

The following layout represents the required metadata elements, along with selected conditional and optional metadata elements, described by this version of the GeoTIFF Implementation Profile. It is merely an outline that denotes a simple view of how the necessary elements are reported. NSG metadata element names are used, as opposed to the equivalent ISO names. Elements appear in the sequence described in ISO 19139, rather than the sequence from Appendix B, which is derived from the NGCMP.

Note that this fictitious metadata documentation represents information for a hierarchy level equal to a dataset. While this version of the metadata profile specification does have the capability to support a variety of hierarchy levels, its scope is limited to support for the most commonly shared types of geospatial data – the dataset.

## D.1 Human-readable Example of Supplementary Metadata - Orthoimage

A generic orthorectified image could include the following example metadata

+ Metadata Entity Set Information
    - metadata file identifier: **SensorX01_-090.40000000_+38.80000000_19971209_13002028.xml** (character string) (Optional)
    - metadata language: **eng** (character string) (code=eng) (Conditional / Mandatory when not defined by encoding)
    - metadata character set: **utf8** (code) (Optional)
    - heirarchy level: **dataset** (code) (Conditional / Mandatory when not = 'dataset')
    - metadata point of contact:
        - organization name: **US National Geospatial-Intelligence Agency** (character string) (Mandatory)
        - telephone number: **+1 314 555 1234** (character string) (Optional)
        - delivery point: **3200 S. Second St.** (character string) (Optional)
        - city: **St. Louis** (character string) (Optional)
        - administrative Area: **MO** (character string) (Optional)
        - postal code: **63118** (character string) (Optional)
        - country: **USA** (code) (Optional)
        - electronic mail address: **DataProduction@nga.mil** (character string) (Optional)
        - role: **Point of Contact** (code) (Mandatory)
    - metadata date stamp: **1997-12-13** (date) (Mandatory)
    - metadata standard name: **ISO 19115 Geographic Information - Metadata** (character string) (Optional)
    - metadata standard version: **First Edition, 2003-05-01** (character string) (Optional)

security: (Mandatory)
classification: **U** (code) (Mandatory)

+ Data Identification Information:
citation:
resource title: **SensorX01_-090.40000000_+38.80000000_19971209_13002028.tif** (character string) (Mandatory)
(naming example from section 7.14)(matches metadata file identifier)
resource date: **1997-12-10** (date) (Mandatory)
resource date type: **creation** (code) (Mandatory)
identifier: **stock number: B13948237**(character string) (Mandatory)
resource abstract: **Panchromatic orthoimage of St. Louis, MO** (character string) (Mandatory)
resource originator: (at least one of 'individual', 'organization', or 'position') (Mandatory)
organization name: **US National Geospatial-Intelligence Agency** (character string) (Conditional)
role: **originator** (code) (Mandatory)
resource point of contact: (at least one of 'individual', 'organization', or 'position') (Optional)
organization name: **NGA Customer Desk** (character string) (Conditional)
telephone number: **+1 800 555 1234** (character string) (Optional)
role: **Resource Provider** (code) (Mandatory)
distribution format: (Mandatory)
distribution format name: **GeoTIFF Rev1.0** (character string) (Mandatory)
distribution format version: **1.8.2** (character string) (Mandatory)
distribution format specification: **Implementation Profile Ver1.0, NGA specification** (character string) (Conditional)
transfer size: **75.3** (real) (Mandatory)
compression: **uncompressed** (character string)(Required in baseline TIFF field)
keyword: **orthoimage** (character string) (Mandatory)
quality: (Optional)
scope level: **dataset** (code) (Mandatory if quality info is described)
name of measure: **horizontal accuracy** (character string)
quantitative result: **5** (character string)
quantitative result unit: **meters** (character string)
security: (Mandatory)
classification: **U** (code) (Mandatory)
dissemination control: **FOUO** (Optional)

rights: **copyright** (code) (Mandatory for imagery)
spatial representation type: **grid** (code) (Optional)
reference system: **Geographic on WGS-84** (character string) (Optional)
resource spatial resolution: (equivalent scale or distance) (Mandatory)
    equivalent scale: **17000** (character string)
dataset language: **eng** (character string) (code=eng) (Mandatory)
resource character set: **utf8** (code) (Mandatory when ISO 10646 not used)
dataset topic category: **imageryBaseMapsEarthCover** (code) (Mandatory if hierarchy level = 'dataset')
image GEO: (list of image vertices – bounding polygon) (decimal degrees) (Mandatory for Imagery)
    position: **-90.40000000 38.80000000**
    position: **-90.20000000 38.80000000**
    position: **-90.200000000 38.60000000**
    position: **-90.40000000 38.60000000**
    position: **-90.40000000 38.80000000**
geographic bounding box: (Conditional – Mandatory if no Geographic Identifier)
    westbound longitude: -**90.4** (decimal degrees)
    eastbound longitude: -**90.2** (decimal degrees)
    southbound latitude: **38.6** (decimal degrees)
    northbound latitude: **38.8** (decimal degrees)
image acquisition date: **1997-12-09** (date) (Mandatory for imagery)
spatial representation:
    type: **grid** (optional)
    geometry: **area** (required by ISO 19115)
    dimensions: (Mandatory for imagery)
        rows:**1536** (character String)
        columns:**1536** (character String)
    transformable to geo: **yes** (required by ISO 19115)

## D.2 XML Instance Document for the Orthoimage Metadata Example

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Example instance document of supplemental metadata in support of the NSG GeoTIFF Profile -->
<!-- This example is based upon the core metadata identified in the NSG Geospatial Core Metadata Profile (NGCMP) ver 1.0) -->
```

```
<!-- The example is based upon the ISO 19115 geospatial metadata model and the corresponding ISO 19139-gmd.xsd schema -->
<MD_Metadata xmlns="http://www.isotc211.org/2005/gmd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:gco="http://www.isotc211.org/2005/gco"
xmlns:gml="http:/www.opengis.net/gml" xmlns:xlink="http://www.w3.org/1999/xlink" xsi:schemaLocation="http://www.isotc211.org/2005/gco http://www.isotc211.org/2005/gco/gco.xsd
http://www.isotc211.org/2005/gmd http://www.isotc211.org/2005/gmd/gmd.xsd http://www.opengis.net/gml http://www.isotc211.org/2005/gml/gml.xsd">
  <fileIdentifier>
    <gco:CharacterString>SensorX01_-090.40000000_+38.80000000_19971209_13002028.xml </gco:CharacterString>
  </fileIdentifier>
  <language>
    <LanguageCode codeList=”http://www.loc.gov/standards/iso639-2/php/code_list.php" codeListValue="eng">English</LanguageCode>
  </language>
  <characterSet>
    <MD_CharacterSetCode codeList="http://www.isotc211.org/2005/resources/Codelist/gmxcodelists.xml#MD_CharactersetCode" codeListValue="utf8">UTF-
8</MD_CharacterSetCode>
  </characterSet>
  <hierarchyLevel>
    <MD_ScopeCode codeList="http://www.isotc211.org/2005/resources/codelist/gmxcodelists.xml#MD_ScopeCode" codeListValue="dataset">Dataset</MD_ScopeCode>
  </hierarchyLevel>
  <contact>
    <CI_ResponsibleParty>
      <organisationName>
        <gco:CharacterString>US National Geospatial-Intelligence Agency</gco:CharacterString>
      </organisationName>
      <contactInfo>
        <CI_Contact>
          <phone>
            <CI_Telephone>
              <voice>
                <gco:CharacterString>+1 314 555 1234</gco:CharacterString>
              </voice>
            </CI_Telephone>
          </phone>
          <address>
            <CI_Address>
              <deliveryPoint>
                <gco:CharacterString>3200 S. Second St.</gco:CharacterString>
              </deliveryPoint>
              <city>
                <gco:CharacterString>St. Louis</gco:CharacterString>
              </city>
              <administrativeArea>
                <gco:CharacterString>MO</gco:CharacterString>
              </administrativeArea>
              <postalCode>
                <gco:CharacterString>63118</gco:CharacterString>
              </postalCode>
              <country>
                <gco:CharacterString>USA</gco:CharacterString>
              </country>
              <electronicMailAddress>
                <gco:CharacterString>DataProduction@nga.mil</gco:CharacterString>
```

```
          </electronicMailAddress>
        </CI_Address>
      </address>
    </CI_Contact>
  </contactInfo>
  <role>
    <CI_RoleCode codeList="http://www.isotc211.org/2005/resources/codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="pointOfContact">Point of Contact/CI_RoleCode>
  </role>
 </CI_ResponsibleParty>
</contact>
<dateStamp>
 <gco:Date>1997-12-13</gco:Date>
</dateStamp>
<metadataStandardName>
 <gco:CharacterString>ISO 19115 Geographic Information - Metadata </gco:CharacterString>
</metadataStandardName>
<metadataStandardVersion>
 <gco:CharacterString>First Edition, 2003-05-01</gco:CharacterString>
</metadataStandardVersion>
<spatialRepresentationInfo>
 <MD_GridSpatialRepresentation>
  <numberOfDimensions>
   <gco:Integer>2</gco:Integer>
  </numberOfDimensions>
  <axisDimensionProperties>
   <MD_Dimension>
    <dimensionName>
     <MD_DimensionNameTypeCode codeList="http://www.isotc211.org/2005/resources/codelist/gmxCodelists.xml#DimensionNameTypeCode"
     codeListValue="row">row</MD_DimensionNameTypeCode>
    </dimensionName>
    <dimensionSize>
     <gco:Integer>1536</gco:Integer>
    </dimensionSize>
   </MD_Dimension>
  </axisDimensionProperties>
  <axisDimensionProperties>
   <MD_Dimension>
    <dimensionName>
     <MD_DimensionNameTypeCode codeList=" http://www.isotc211.org/2005/resources/codelist/gmxCodelists.xml#DimensionNameTypeCode"
     codeListValue="column">column</MD_DimensionNameTypeCode>
    </dimensionName>
    <dimensionSize>
     <gco:Integer>1536</gco:Integer>
    </dimensionSize>
   </MD_Dimension>
  </axisDimensionProperties>
  <cellGeometry>
    <MD_CellGeometryCode codeList=" http://www.isotc211.org/2005/resources/codelist/gmxCodelists.xml#CellGeometryCode"
  codeListValue="area">area</MD_CellGeometryCode>
  </cellGeometry>
```

```
    <transformationParameterAvailability>
      <gco:Boolean>true</gco:Boolean>
    </transformationParameterAvailability>
  </MD_GridSpatialRepresentation>
 </spatialRepresentationInfo>
 <referenceSystemInfo>
  <MD_ReferenceSystem>
   <referenceSystemIdentifier>
    <RS_Identifier>
     <code>
      <gco:CharacterString>WGS84G</gco:CharacterString>
     </code>
     <codeSpace>
       <gco:CharacterString>http://www.isotc211.org/2005/resources/crs/gmxCrs.xml>
     </codeSpace>
    </RS_Identifier>
   </referenceSystemIdentifier>
  </MD_ReferenceSystem>
 </referenceSystemInfo>
 <identificationInfo>
  <MD_DataIdentification>
   <citation>
    <CI_Citation>
     <title>
      <gco:CharacterString>SensorX01_-090.40000000_+38.80000000_19971209_13002028.tif</gco:CharacterString>
     </title>
     <date>
      <CI_Date>
       <date>
        <gco:Date>1997-12-10</gco:Date>
       </date>
       <dateType>
        <CI_DateTypeCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="creation">Creation</CI_DateTypeCode>
       </dateType>
      </CI_Date>
     </date>
     <identifier>
      <MD_Identifier>
       <authority xlink:href="#NationalStockNumber" />
       <code>
        <gco:CharacterString>B13948237</gco:CharacterString>
       </code>
      </MD_Identifier>
     </identifier>
    </CI_Citation>
   </citation>
   <abstract>
    <gco:CharacterString>Panchromatic orthoimage of St. Louis, MO</gco:CharacterString>
   </abstract>
```

```
    <pointOfContact>
      <CI_ResponsibleParty>
        <organisationName>
          <gco:CharacterString>US National Geospatial-Intelligence Agency</gco:CharacterString>
        </organisationName>
        <role>
          <CI_RoleCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="originator">Originator</CI_RoleCode>
        </role>
      </CI_ResponsibleParty>
    </pointOfContact>
    <pointOfContact>
      <CI_ResponsibleParty>
        <organisationName>
          <gco:CharacterString>NGA Customer Desk</gco:CharacterString>
        </organisationName>
        <contactInfo>
          <CI_Contact>
            <phone>
              <CI_Telephone>
                <voice>
                  <gco:CharacterString>+1 800 555 1234</gco:CharacterString>
                </voice>
              </CI_Telephone>
            </phone>
          </CI_Contact>
        </contactInfo>
        <role>
      <CI_RoleCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#CI_RoleCode" codeListValue="resourceProvider">Resource
Provider</CI_RoleCode>
        </role>
      </CI_ResponsibleParty>
    </pointOfContact>
    <resourceFormat>
      <MD_Format>
        <name>
          <gco:CharacterString>GeoTIFF Rev1.0</gco:CharacterString>
        </name>
        <version>
          <gco:CharacterString>1.8.2</gco:CharacterString>
        </version>
      </MD_Format>
    </resourceFormat>
    <descriptiveKeywords>
      <MD_Keywords>
        <keyword>
          <gco:CharacterString>Orthoimage</gco:CharacterString>
        </keyword>
      </MD_Keywords>
    </descriptiveKeywords>
    <resourceConstraints>
```

```
      <MD_LegalConstraints>
        <useConstraints>
          <MD_RestrictionCode codeList=" http://www.isotc211.org/2005/resources/codeList#MD_RestrictionCode" codeListValue="copyright">Copyright</MD_RestrictionCode>
        </useConstraints>
      </MD_LegalConstraints>
    </resourceConstraints>
    <resourceConstraints>
      <MD_SecurityConstraints>
        <classification>
          <MD_ClassificationCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ClassificationCode"
codeListValue="unclassified">U</MD_ClassificationCode>
        </classification>
        <handlingDescription>
          <gco:CharacterString>FOUO</gco:CharacterString>
        </handlingDescription>
      </MD_SecurityConstraints>
    </resourceConstraints>
    <spatialRepresentationType>
      <MD_SpatialRepresentationTypeCode codeList="http://www.isotc211.org/2005/resources/codeList.xml#MD_SpatialRepresentationTypeCode"
codeListValue="grid">grid</MD_SpatialRepresentationTypeCode>
    </spatialRepresentationType>
    <spatialResolution>
      <MD_Resolution>
        <equivalentScale>
          <MD_RepresentativeFraction>
            <denominator>
              <gco:Integer>17000</gco:Integer>
            </denominator>
          </MD_RepresentativeFraction>
        </equivalentScale>
      </MD_Resolution>
    </spatialResolution>
    <language>
      <LanguageCode codeList=" http://www.isotc211.org/2005/resources/Codelist/ML_gmxCodelists.xml#LanguageCode" codeListValue="eng">English</LanguageCode>
    </language>
    <characterSet>
      <MD_CharacterSetCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_CharacterSetCode" codeListValue="utf8">UTF-
8</MD_CharacterSetCode>
    </characterSet>
    <topicCategory>
      <MD_TopicCategoryCode>imageryBaseMapsEarthCover</MD_TopicCategoryCode>
    </topicCategory>
    <extent>
      <EX_Extent>
        <geographicElement>
          <EX_GeographicBoundingBox>
            <westBoundLongitude>
              <gco:Decimal>-90.4</gco:Decimal>
            </westBoundLongitude>
            <eastBoundLongitude>
```

```
          <gco:Decimal>-90.2</gco:Decimal>
         </eastBoundLongitude>
         <southBoundLatitude>
          <gco:Decimal>38.6</gco:Decimal>
         </southBoundLatitude>
         <northBoundLatitude>
          <gco:Decimal>38.8</gco:Decimal>
         </northBoundLatitude>
        </EX_GeographicBoundingBox>
       </geographicElement>
      </EX_Extent>
     </extent>
     <extent>
      <EX_Extent>
       <geographicElement>
        <EX_BoundingPolygon xmlns:gml="http://www.opengis.net/gml">
         <polygon>
          <gml:Polygon gml:id="detailedExtent">
           <gml:exterior>
            <gml:LinearRing>
             <gml:pos>-90.40000000 38.80000000</gml:pos>
             <gml:pos>-90.20000000 38.80000000</gml:pos>
              <gml:pos>-90.20000000 38.60000000</gml:pos>
             <gml:pos>-90.40000000 38.60000000</gml:pos>
             <gml:pos>-90.40000000 38.80000000</gml:pos>
            </gml:LinearRing>
           </gml:exterior>
          </gml:Polygon>
         </polygon>
        </EX_BoundingPolygon>
       </geographicElement>
       <temporalElement>
        <EX_TemporalExtent xmlns:gml="http://www.opengis.net/gml">
         <extent>
          <gml:TimeInstant gml:id="imageAcquisitionDate">
           <gml:timePosition>1997-12-09</gml:timePosition>
          </gml:TimeInstant>
         </extent>
        </EX_TemporalExtent>
       </temporalElement>
      </EX_Extent>
     </extent>
    </MD_DataIdentification>
  </identificationInfo>
  <dataQualityInfo>
   <DQ_DataQuality>
    <scope>
     <DQ_Scope>
      <level>
       <MD_ScopeCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ScopeCode" codeListValue="dataset">Dataset</MD_ScopeCode>
```

```
        </level>
       </DQ_Scope>
      </scope>
      <report>
       <DQ_AbsoluteExternalPositionalAccuracy>
        <nameOfMeasure>
         <gco:CharacterString>Horizontal Accuracy</gco:CharacterString>
        </nameOfMeasure>
        <result>
         <DQ_QuantitativeResult>
          <valueUnit xlink:href=”http://www.isotc211.org/2005/resources/uom/gmxUom.xml#metre/>
          <value>
           <gco:Record>
            <gco:Real>5.0</gco:Real>
           </gco:Record>
          </value>
         </DQ_QuantitativeResult>
        </result>
       </DQ_AbsoluteExternalPositionalAccuracy>
      </report>
    </DQ_DataQuality>
  </dataQualityInfo>
  <metadataConstraints>
    <MD_SecurityConstraints>
     <classification>
      <MD_ClassificationCode codeList=" http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ClassificationCode"
codeListValue="unclassified">U</MD_ClassificationCode>
     </classification>
    </MD_SecurityConstraints>
  </metadataConstraints>
</MD_Metadata>
```

# Appendix E – Abstract Test Suite

## E.1 Purpose, Scope, and Methodology

### Purpose

To determine the extent a system or product conforms to this profile for the interpretation and generation of GeoTIFF and supplemental metadata files as constrained by this implementation profile.

### Scope

Conformance testing will focus on the GeoTIFF features and supplemental metadata capabilities of the tested system or product. Testers will check for conformance with this profile and also with the standards and specifications that were used as normative documents in the construction of this profile. The intent is to provide a high level of confidence that an implementation conforms to the profile. The term 'GeoTIFF' as used within the context of this appendix generally means TIFF, GeoTIFF and supplemental metadata as specified by this profile.

### Methodology

The GeoTIFF testing methodology uses a combination of test cases designed to address the ability of the Implementation Under Test (IUT) to interpret and/or generate GeoTIFF compliant data files. The test sponsor fills out the Implementation Conformance Statements (ICS) shown in E.2. The tester uses this information to design the test scenarios and set of test cases to be used in the test campaign. The test scenarios and test cases exercise the following test strategy:

Interpret: The interpret portion of GeoTIFF compliance testing determines the degree to which a GeoTIFF application can properly interpret GeoTIFF formatted files. Interpret applications, at a minimum, must be robust enough to unpack, interpret, and display any GeoTIFF compliant file. Testers present the IUT with test case files designed to exercise the minimum required capabilities for all interpret applications. Testers also present the IUT with test case files designed to exercise the optional GeoTIFF features the IUT is required to support as designated by the test sponsor.

Generate: The generate portion of GeoTIFF compliance testing determines the degree to which a system can generate fully compliant GeoTIFF formatted files. For generate testing, the test sponsor designates the specific GeoTIFF capabilities and features the IUT is required to support for generation of GeoTIFF files. Testers design test scenarios for production of GeoTIFF files (test cases) that exercise the required capabilities and features against the applicable test criteria. The IUT operator generates test case files under the guidance of these test scenarios. The testers evaluate the output test case files for compliance with the applicable portions of the GeoTIFF profile using automated test tools (when available) and visual inspection.

Data Conformance: Criteria used in the test campaign to evaluate data conformance include:

1. Completeness: checks for presence of mandatory (required) elements. A comparison test shall also be performed to determine if all tags/keys/elements defined as conditional are present when the conditions described in the profile apply.

2. Maximum occurrence (supplemental metadata only, all levels of obligation): ensures each metadata element occurs no more than the number of times specified in this profile.

3. Data Type (all levels of obligation): the value of each provided metadata element is tested to ensure its data type adheres to the data type specified.

4. Domain (supplemental metadata only, all levels of obligation): the values of each metadata element are tested to ensure they fall within the specified domain.

5. Schema (supplemental metadata only, all levels of obligation): test each metadata element and ensure it is contained within the specified schema entity.

   *Note1: Minimum conformance requires that the supplemental metadata instance (XML) documents can be validated without error against the XML schemas defined by this profile. While many tools are available to test validation of XML instance documents against provided XML Schemas, it is important to understand that not all validation tools implement the full W3C XML Schema recommendation and not all validation tools interpret the W3C XML Schema recommendation in the same manner. It is recommended that a tool with strict interpretation of XML Schema and full support for the W3C XML Schema recommendation be used to ensure conformance.*

   *Note 2: Validation of XML instance documents against the schemas described in this document is not all that is required for conformance to this specification. A property element is designed to have content (by-value) or attributes (by-reference or NULL with reason). However, because of the design, the property element may have no content or attributes, or it may have both content and attributes and still be XML Schema-valid. It is not possible to constrain the co-occurrence of content or attributes. Some mechanism in addition to an XML Schema validation must be used to restrict a property to be exclusively by-value, or by-reference, or expressing a NULL reason.*

   *Note 3: XML Schema does not support the enforcement of certain types of constraints documented in this profile. For example, conditional constraints to force selection of one or more items from a list of optional items are not always enforceable within XML schema. Neither are co-constraints enforceable such as requirements to include elements based on values contained in other elements. These conditions must be evaluated through inspection.*

6. Standard Metadata (supplemental metadata only, all levels of obligation): if the implementer adds metadata beyond what is described in this profile, the additional metadata is selected from ISO 19115 standard metadata whenever possible.

7. Exclusiveness (supplememental metadata only, all levels of obligation): if the implementer adds metadata beyond what is described in 19115, each user-defined metadata section, metadata entity, and metadata element is unique and not already defined in 19115.

   *Note: user-defined metadata within a subject metadata set must satisfy the same requirements as set forth in this ATS.*

8. Definition (supplemental metadata only, all levels of obligation): if the implementer adds metadata beyond what is described in this profile, the elements are tested to ensure that all attributes have been defined.

9. File Format (TIFF structure): The TIFF file structure is as defined by the TIFF specification, and as constrained by this profile.

10. GeoTIFF (GeoTIFF tags): The GeoTIFF tag structures are as defined by the GeoTIFF specification, and as constrained by this profile.

## E.2 Implementation Conformance Statements (ICS)

**Table E.2.1: Baseline TIFF ICS**

| Tagged Image File Format | ICS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | INTERPRET | | | | | GENERATE | | | | |
| TIFF Revision 6.0 | | | | | | | | | | |
| **Features** | INTERPRET | | | | | GENERATE | | | | |
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| **Copyright** | | | | | | | | | | |
| Include Copyright statement | | | | | | | R | | | |
| Display Copyright statement | | R | | | | | | | | |
| **Date/Time** | | | | | | | | | | |
| Date and time of image creation | | | | | | | R | | | |
| Display date and time of image creation | | R | | | | | | | | |
| **Fill Order** | | | | | | | | | | |
| Value = 1 (pixels with lower column values are stored in the higher-order bits of the byte) | | R | | | | | O[5] | | | |
| **Host Computer** | | | | | | | | | | |
| System used in creation of range values | | | | | | | O | | | |
| Display system used | | O | | | | | | | | |
| **Image Description** | | | | | | | | | | |
| Security Banner + Abstract Information | | | | | | | R | | | |
| Display Image Description | | R | | | | | | | | |
| **Image Length and Width** | | | | | | | | | | |
| Length and Width in Pixels | | | | | | | R | | | |
| Display Image in Accordance with Length and Width Values | | R | | | | | | | | |
| **Make and Model** | | | | | | | | | | |
| Instrument Make and Model | | | | | | | R | | | |
| Display Instrument Make and Model | | O | | | | | | | | |

| Features | INTERPRET | | | | | GENERATE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| **Max/Min Sample Value** | | | | | | | | | | |
| Max/Min values (integer) | | | | | | | O[1] | | | |
| Smax/Smin values (noninteger) | | | | | | | O[1] | | | |
| Automatic Dynamic Range Adjustment | | O | | | | | | | | |
| **Orientation** | | | | | | | | | | |
| Value = 1 (top and left sides displayed are 0th row and column) | | R | | | | | O[5] | | | |
| **Planar Configuration** | | | | | | | | | | |
| Value = 1 (component values for each pixel are stored contiguously)(chunky format) | | R | | | | | R[3] | | | |
| **Samples Per Pixel** | | | | | | | | | | |
| 1 (grayscale) | | R | | | | | O[1] | | | |
| 3 (RGB) | | R | | | | | O[1] | | | |
| 4 (4-Band Color) | | R | | | | | O[1] | | | |
| ExtraSamples = 1 (4-Band Case) | | R | | | | | O[2] | | | |
| **Bits Per Sample** | | | | | | | | | | |
| 1 | | R | | | | | O[2] | | | |
| 8 | | R | | | | | O[1] | | | |
| 16 | | R | | | | | O[1] | | | |
| 32 | | R | | | | | O[4] | | | |
| **Transparency Mask** | | | | | | | | | | |
| NewSubfileType: Bit 2 = 1, all other bits = 0 | | | | | | | O[2] | | | |
| Display a transparency mask | | R | | | | | | | | |
| **Tiling** | | | | | | | | | | |
| Tile Length and Width | | R | | | | | O[2] | | | |
| Tile Offsets | | R | | | | | O[2] | | | |
| Tile Byte Counts | | R | | | | | O[2] | | | |

| Features | INTERPRET | | | | | GENERATE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| **Photometric Interpretation** | | | | | | | | | | |
| 1 (Black is Zero) | | R | | | | | O[1] | | | |
| 2 (RGB) | | R | | | | | O[1] | | | |
| 3 Palette Color | | R | | | | | O[1] | | | |
| 4 Transparency Mask | | R | | | | | O[2] | | | |
| **ColorMap** | | | | | | | | | | |
| Define an RGB Color Map | | | | | | | O[2] | | | |
| Apply Color Map to Image | | R | | | | | | | | |
| **Artist** | | | | | | | | | | |
| Populate with Organization Name & Role | | | | | | | R | | | |
| Display Field Contents | | R | | | | | | | | |
| **X/Y Resolution** | | | | | | | | | | |
| Populate with intended display resolution | | | | | | | R | | | |
| Display at specified resolution | | R | | | | | | | | |
| **Resolution Unit** | | | | | | | | | | |
| Value = 2 (inches) | | R | | | | | R | | | |
| **Software** | | | | | | | | | | |
| Populate with Name of Software Package | | | | | | | R | | | |
| Display Software Package Name | | O | | | | | | | | |
| **Sample Format** | | | | | | | | | | |
| 1 (unsigned integer) | | R | | | | | O[1] | | | |
| 2 (two's complement signed integer) | | R | | | | | O[1] | | | |
| 3 (IEEE floating point) | | R | | | | | O[1] | | | |
| **Compression** | | | | | | | | | | |
| Value = 1 (no compression) | | R | | | | | O[5] | | | |
| **Strips** | | | | | | | | | | |
| Rows per Strip | | R | | | | | O[2] | | | |
| Strip Byte Counts | | R | | | | | O[2] | | | |
| Strip Offsets | | R | | | | | O[2] | | | |

| Features | INTERPRET | | | | | GENERATE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| **Thresholding** | | | | | | | | | | |
| Value = 1 (no dithering or halftoning) | | R | | | | | O[5] | | | |
| **No Data Value** | | | | | | | | | | |
| Populate GDAL_NODATA tag | | | | | | | R | | | |
| Interpret value as void/suspect area | | R | | | | | | | | |
| **Geo Metadata** | | | | | | | | | | |
| Supplemental Metadata | | R | | | | | O[2] | | | |

**LEGEND:**

N - Non-supported
N/A – Not Applicable
P - Partial support
R/O - Required/Optional
S – Full Support
(1) - At least one of the options must be implemented
(2) - Required if feature is present
(3) - Required if image is multiband
(4) - Option for gridded data other than image
(5) - Desired but optional

**Table E.2.2: GeoTIFF ICS**

| Tagged Image File Format | ICS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | INTERPRET | | | | | GENERATE | | | | |
| GeoTIFF Revision 1.0, Specification 1.8.2 | | | | | | | | | | |
| **Features** | INTERPRET | | | | | GENERATE | | | | |
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| **Tags** | | | | | | | | | | |
| GeoKeyDirectoryTag | | | | | | | | | | |
| All keys referenced | | R | | | | | R | | | |
| GeoAsciiParamsTag | | | | | | | | | | |
| All ASCII type GeoKeys stored | | R | | | | | R | | | |
| ModelTiePointTag | | | | | | | | | | |
| Grid Origin X, Y | | R | | | | | R | | | |
| Grid Origin Z | | O | | | | | R[5] | | | |
| ModelPixelScaleTag | | | | | | | | | | |
| ScaleX, ScaleY | | R | | | | | R | | | |
| Scale Z | | O | | | | | R[5] | | | |
| ModelTransormationTag | | R | | | | | R[6] | | | |
| **Configuration GeoKeys** | | | | | | | | | | |
| GTModelTypeGeoKey | | | | | | | | | | |
| 1 - Projected | | R | | | | | O[1] | | | |
| 2 - Geographic | | R | | | | | O[1] | | | |
| GTRasterTypeGeoKey | | | | | | | | | | |
| 1 - Pixel is Area | | R | | | | | O[1] | | | |
| 2 - Pixel is Point | | R | | | | | O[1] | | | |
| GTCitationGeoKey | | | | | | | | | | |
| Value as defined in Table A.2.1 | | R | | | | | R | | | |
| Coordinate Type is Required for Only One of the Following Sets of Keys: | | | | | | | | | | |
| **Geographic Coordinate System Parameter Keys[3]** | | | | | | | | | | |
| GeographicTypeGeoKey | | | | | | | | | | |
| 4326 – GCS WGS 84 | | R | | | | | O[2] | | | |
| 4030 - GCSE WGS 84 | | R | | | | | O[2] | | | |
| GeogCitationGeoKey | | | | | | | | | | |

| Features | INTERPRET | | | | | GENERATE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | √ | R/O | S | P | N | √ | R/O | S | P | N |
| Value = WGS84 [DMA TR 8350.2] | | R | | | | | R | | | |
| **Projected Coordinate System Parameter Keys**[4] | | | | | | | | | | |
| ProjectedCSTypeGeoKey | | | | | | | | | | |
| 326zz – UTM North | | R | | | | | O[2] | | | |
| 327zz – UTM South | | R | | | | | O[2] | | | |
| PCSCitationGeoKey | | | | | | | | | | |
| Value = see Table A.2.3 | | R | | | | | R | | | |
| **Vertical Coordinate System Parameter Keys**[5] | | | | | | | | | | |
| VerticalCSTypeGeoKey | | | | | | | | | | |
| 5030 – WGS 84 | | O | | | | | O[2] | | | |
| 5171 – EGM96 Geoid | | O | | | | | O[2] | | | |
| 5203 – EGM84 Geoid | | O | | | | | O[2] | | | |
| 32767 – user defined | | O | | | | | O[2] | | | |
| VerticalCitationGeoKey | | | | | | | | | | |
| Value = see Table A.2.4 | | O | | | | | R | | | |
| VerticalUnitsGeoKey | | | | | | | | | | |
| Value = 9001 (linear meter) | | O | | | | | R | | | |

**LEGEND:**

N - Non-supported
P - Partial support
R/O - Required/Optional
S – Full Support
(1) - At least one of the options must be implemented
(2) - At least one of the options must be implemented when feature is present
(3) - Required for unprojected data
(4) - Required for projected data
(5) - Required for elevation data
(6) - Required when image requires rotation in order to be north-oriented

**Table E.2.3: Supplemental Metadata ICS**

(using example elements from Appendix B)

| Features | √ | R/O | Interpret | S | √ | R/O | Generate | S |
|---|---|---|---|---|---|---|---|---|
| **Metadata Location** | | | | | | | | |
| Embedded in GeoTIFF | | R | Recognize, extract and display contents of internal XML (tag 50909). Feature parameters are provided to application processes as necessary. | | | O[1] | Use GeoTIFF tag 50909 to incorporate supplemental metada in XML form, conforming to Supplemental Metadata XML Schema in Appendix C. | |
| External XML file | | R | Parse and display contents of file. Metadata parameters are provided to native application processes as necessary. | | | O[1] | External file content conforms to Supplemental Metadata XML Schema in Appendix C. | |
| **Mandatory Elements** | | | | | | | | |
| Validated by XML Schema | | R | Parse and display (at a minimum). | | | R | Mandatory elements present and validated | |
| **Support for Conditional Elements** | | | | | | | | |
| hierarchy level | | R | Support multiple levels of data and metadata. | | | O[2] | Applicable code from table B.2.3 | |
| hierarchy level name | | R | Display name and associate the levels of metadata with their corresponding data. | | | O[2] | Free text | |
| dataset topic category | | R | Display topic category from table B.2.4. | | | O[3] | Applicable code from table B.2.4 | |
| geographic bounding box | | R | Display when values are present. | | | O[1] | Compound; set of 4 real numbers | |
| geographic identifier | | R | Display when values are present. | | | O[1] | Free text; FIPS 10-4 code | |
| temporal extent | | R | Display. | | | O[4] | Class; from ISO 19108 | |
| resource character set | | R | Display character set name when element is present. | | | O[5] | Applicable code from table B.2.5 | |
| metadata language | | R | Display code when element is present. | | | O[6] | Applicable code from ISO 639-2 | |
| online resource | | R | Display URL. | | | O[7] | URL of dataset source | |
| distribution format specification | | R | Display. | | | O[4] | Free text; detailed product specification (matching | |

| Features | √ | R/O | Interpret | S | √ | R/O | Generate | S |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | GTCitationGeoKey in table A.2.1) | |
| equivalent scale | | R | Display. | | | O[1] | Integer; Include denominator of scale fraction | |
| distance | | R | Display. | | | O[1] | Class; from ISO 19103, includes distance and units | |
| **Support for Optional Elements** | | | | | | | | |
| metadata standard name | | R | Display. | | | O | Value = NSG Geospatial Core Metadata Profile | |
| metadata standard version | | R | Display. | | | O | Value = 1.0 | |
| metadata character set | | R | Display character set. | | | O | Applicable code from table B.2.5 | |
| spatial representation type | | O | Display spatial representation type = grid. | | | O | Value = 002 grid | |
| resource point of contact | | R | Display. | | | O | Compound element from table B.1.2. Include at least organization name and role | |
| lineage | | R | Display. | | | O | Free text | |
| reference system | | R | Display reference system. | | | O | Free text. For geographic and projected, use codes from tables A.2.2 and A.2.3 | |
| metadata file identifier | | R | Display. | | | O | Free text. If metadata is external, match GeoTIFF file name | |
| vertical extent | | R | Display. | | | O | Compound element from table B.1.1 | |
| use | | R | Display. | | | O | Free text | |
| quality | | R | Display. | | | O | Per table B.2.7. Include at least scope level and result for each measure | |
| radiometric resolution | | R | Display. | | | O | Integer. Value = 8, 16, or 32 | |
| **Metadata Extensions** | | | | | | | | |
| Extensions included in ISO 19115 | | R | Display (at a minimum). | | | O | Comply with ISO19115 and ISO 19139. Provide list of elements supported. | |
| Extensions beyond ISO 19115 | | R | Display (at a minimum). | | | O | Provide list of metadata extensions. Scope of extensions is limited to discovery and retrieval. | |

**LEGEND:**

(1) – at least one of the options must be implemented
(2) – required if hierarchy level not = dataset
(3) – required if hierarchy level = dataset
(4) – required when applicable to dataset
(5) – required when ISO 10646-1 not used
(6) – required when not defined by the encoding
(7) – required when ‘geographic bounding box’ and ‘temporal extent’ not documented
(8) – required when including the optional element ‘number of source images’